DISCOVERY

A MONTHLY POPULAR JOURNAL OF KNOWLEDGE

EDITED BY EDWARD LIVEING, B.A.
SCIENTIFIC ADVISER: A. S. RUSSELL, D.Sc.

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A CITY IN THE SAHARA OVER 3,000 YEARS OLD
The walls of Siwa as seen from outside

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JOHN MURRAY, 50A ALBEMARLE STREET, LONDON, W.1.

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DISCOVERY. A Monthly Popular Journal of Knowledge.

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Editorial Notes

IT was reported in a local paper a few weeks ago that the "Tut craze" had vanished into thin air and that a Hebrew merchant, interviewed in a "curiosity" shop, wrung his hands as he pointed to a heap of Egyptian dresses and odds and ends of furniture, carved in Oriental style, in a corner, remarking, "Look at all that junk there; all interest in the Luxor discoveries has disappeared, and that stuff is absolutely valueless." We hasten to assure the sad merchant that the "Tut craze" will be revived this autumn when Mr. Howard Carter resumes work on the Pharaoh's tomb. The chief interest in the further investigations will be focused on the opening of the dead monarch's sarcophagus. If this reveals the mummy, which in all likelihood it will do, an X-ray examination will be made. In this event a further sentimental campaign against desecration will probably force its way into the pages of the daily press. We should like in as few words as possible to emphasise what we consider to be the right attitude towards this idea of desecration.

* * * * *

In the first place Tutankhamon's mummy will almost certainly be restored to its sarcophagus after X-ray examination. The only motive which would urge Mr. Howard Carter to remove it to the Cairo Museum would be a consideration for its greater safety. In our February issue Dr. Blackman wrote an article on the Plundering of the Royal Tombs at Thebes in the Twentieth and Twenty-first Dynasties. Of these ravages we have definite documentary evidence which was admirably summarised by Dr. Blackman. But it was not merely at this period, but much earlier and, indeed, ever since that the inhabitants of the district round Luxor have plied a thriving trade in despoiling the tombs of their furniture and often even in cutting up the mummies and selling the pieces. As Professor Elliot Smith reminds us in a recently published book,[1] Sir Thomas Browne wrote two and a half centuries ago that "the Egyptian mummies which Cambyses or time hath spared, avarice now consumeth. Mummy is become merchandise, Mizraim cures wounds, and Pharaoh is sold for balsams." Thieves abound in Egypt to-day in all "tomb" localities, as anyone who has visited Egypt and interested himself in its archæology will testify; and when they probe into a tomb not touched by an Egyptologist, little is left of the things inside and even the mural paintings are chipped out of the walls. Under the circumstances two alternatives can be adopted in the case of Tutankhamon's mummy: if it is left to repose in its original resting-place, then it will have to be continually and rigidly guarded; if it is not so guarded, it had better be removed to Cairo. So numerous have been the ravages in the past that the only royal mummy hitherto found in its own tomb was that of the Pharaoh, Amenhotep II. In the case of this discovery, the first alternative was adopted, and it was adopted by none other than Mr. Howard Carter, at that time the Inspector of Antiquities at Luxor.

* * * * *

Any objections raised to the examination of the body by X-rays are foolish. No harm can be inflicted upon it by such an examination, as Professor Elliot Smith and other authorities have pointed out. But, on the other hand, a great amount of valuable information will be so gained about the physical qualities and diseases of the inhabitants of Egypt living nearly

[1] *Tutankhamon and the Discovery of his Tomb.* By Prof. G. Elliot Smith, F.R.S., etc. (Routledge, 4*s.* 6*d.*)

3,500 years ago and of the methods of embalming in use at the time.

* * * * *

A subject which no serious-minded man can neglect to-day is that of research into what are known as Psychical phenomena. There are few people who are entirely convinced that every incident in life, and especially in the relationships between human beings, can be satisfactorily explained by known and established physical laws. For example, there appear to be undoubted cases of what is known as Telepathy. The parlour-game trick of selecting five playing cards, grasping the hand of another person who keeps his eyes shut, and bidding him choose a selected card from the five, succeeds far more often than is accounted for by the laws of chance. There are, of course, possibilities of error; for example, slight involuntary movements may direct the hand. Apart from this particular case, most people can recall a personal experience where there appears at first sight, whatever be the truth, to be an intuition concerning the doings or fate of an intimate friend at a distance. The investigation of any experience of this sort is manifestly a matter of intense difficulty. Coincidence can rarely be excluded; self-deception and wilful deception must be considered before any other explanation of seemingly mysterious happenings. It does not seem at all impossible, however, that man should possess either some traces of a power of receiving communications otherwise than through the recognised channels, or should slowly be evolving that power through the intimate social relationships imposed by his communal organisation. But the fact that a great number of curious little experiments and inexplicable happenings deserve further inquiry does not call for an immediate abandonment of all simple explanations of such things.

* * * * *

In this connection we would like to refer to an article in that excellent quarterly review of psychology, *Psyche*, for April 1923, with which some of our readers will be familiar. The article in question is called *Convincing Phenomena at Munich.* A few quotations will show what these phenomena were. A medium, known as "Willy," was provided by Baron von Schrenck-Notzing, in whose private house the mysterious happenings occurred. It should be mentioned that a previous series of queer events had taken place in the Baron's presence with a medium known as Eva. It is surely natural to expect, therefore, that the individual who was present on both occasions, namely the Baron, should have been particularly investigated. However, the company devoted their attention to Willy, who was dressed in tights, and whose hands were both held. The hands of the rest of the company were also clasped—all save the Baron's, one of whose hands was free. In almost complete darkness things began to happen. "A small table (on which was placed a luminous rectangular card and a luminous bracelet) was placed on a larger table in front of a large cabinet. After the medium became entranced the card was moved, the bracelet was waved in the air, the table was knocked over. These same phenomena occurred again after an interval of a minute or two, the smaller table being passed, with one pause, completely round the larger one."

* * * * *

The writer, Mr. H. Price, goes on to note that this pause would be accounted for if the table had been moved by a human being with one hand only. And still no one seems to have thought of the Baron's other hand! We preserve as open a mind as possible concerning the value of these examples of "Levitation." But we would like to see, as a first preliminary to establishing the super-normal nature of these rather trivial little adventures of domestic furniture, the Baron attired in tights, with both his hands grasped. It would appear, to a casual observer, that the attention directed to Willy recalls the exhortations of the conjurer to "Watch my right hand" while his left is busy somewhere in the background. And even if all the precautions of which we could think proved futile to restrain the Baron's belongings from inordinate activity, we cannot help admitting that the frankly engineered mysteries of Maskelyne and Devant in broad daylight fill us with far more superstitious awe than musical-boxes that obey the word of command, and slowly rising handkerchiefs.

* * * * *

Those whose good fortune takes them to the South Downs of England will have noticed, as one of their outstanding features, the barrows and grassy earthworks which crown many of the heights. They are referred to in Kipling's Sussex poem:

> "What sign of those that fought and died
> At shift of sword and sword?
> The barrow and the camp abide,
> The sunlight and the sward."

Many will have wondered what these remains signify—how ancient they are, and what manner of person built them. A novel and, it would appear, most important method of investigating these questions is by means of air photographs. Mr. O. G. S. Crawford, who during the war took many such photographs over enemy ground, has been inspired to use this means of surveying wide stretches of downland. He has described his results in the *Geographical Journal* for May 1923. "The diagrams I have made," he writes, "are nothing less than accurate plans of the

fields of a group of communities which ceased to exist about 1,500 years ago. Remains of the villages where lived the people who cultivated these fields can still be seen upon the downlands of Wessex and Sussex." The essential function of air photography is that it makes evident the plan and arrangement of ancient fields and roads which, from the ground, appear only as broad banks with no definite arrangement. Their relation to remains of known Roman origin proves that they were in existence before the Roman conquest. They prove that agriculture was well developed in southern England long before that event. Moreover, it is evident, from the isolated round white spots due to localised patches of chalk, that the custom which still persists of "marling" or fertilising the fields with chalk brought from a distance was established in very ancient times. These cultivations, the author believes, were the works of Celtic communities; the Saxons preferred the rich valleys by the streams. It is strange to read of the long-forgotten relics of ancient days brought to light by the aid of one of the newest of scientific methods—air photography. Above all, these discoveries serve to emphasise again the antiquity of the downland, and its grandeur, unspoilt as yet by all the artificiality and commercial development of modern England.

"But here the old Gods guard their round,
And in her secret heart
The heathen-kingdom Wilfrid found
Dreams, as she dwells, apart."

* * * * *

We feel that the importance, even greater to all who love their native land and its gradually vanishing countryside than to the specialised interest of the archæologist, of restraining the hand of the spoiler in the shape of the advertiser, justifies a reference in this place to the Bill now before Parliament to curtail his activity. A peculiarly offensive example is to be seen, carved in the chalk outside Lewes, in the heart of Downland, in letters many yards long. It is a most unpleasing experience to walk from the Long Man of Wilmington, carved in the chalk unknown hundreds of years ago, to this modern atrocity. We trust that the Bill will safely make its way through the devious routes of Parliamentary procedure, and take effect at an early date. Surely the feeling of antagonism inspired by the thoroughly distasteful exhortation to purchase some commodity must completely outweigh the advantage of any publicity so gained. Unfortunately, a determination never to purchase any article so recommended would quickly prevent a public-spirited individual to-day from buying anything, so widespread is the habit. But, short of legislation, such a course seems the only logical way to set a term to the nuisance.

The Structure of the Earth [1]

A New Theory

By O. H. T. Rishbeth, M.A.

Reader in Geography in the Southampton University College of Wessex

THIS is the century of world views and world vision in matters of business, social construction, and politics; it is also the century of world aspects in matters intellectual, in history, economics, and, not least, in geography and geology. There is a growing interest in problems connected with the physical nature of our world as a whole, its composition, structure, the distribution of elements in and upon it, and the reasons for that distribution. Recently prominence has been given in discussion to Wegener's theory [2]—the theory of the drifting apart of continents. It may be of interest to acquaint ourselves with another theory, even more ambitious in its scope, which will perhaps come prominently into notice, and which bears the marks of greatness. The theory is the result of "long years of study in the field and in the literature of the subject," and its author, since the appearance of the book in which he sets it forth, has been appointed to one of the most important chairs in his subject on the Continent.

The problem of mountain-building has long occupied the minds of thinkers, and its connection with the equally absorbing subject of the nature and structure of the ocean basins has become increasingly emphasised. The Pacific is bordered by chains, the apparent remnants of a mighty mountain girdle. The great Eurasiatic mountain-zone breaks off east and west into oceans, is flanked by flooded hollows almost throughout its length, and is never far from the ocean. Nearly all the great mountain systems, old or young, are contiguous to continental margins,[3] while the hearts of the continents are relatively undisturbed. The existence of mountains and orographical features generally on the ocean floors has long been recognised, and although the whole subject remains a field of conflicting theories, the great oceanic troughs (geosynclines) are frequently regarded as the wombs or the graves of mountains.

Kober builds with existing materials. His method is evolutionary rather than revolutionary: he absorbs,

[1] L. Kober, *Der Bau der Erde* (Geb. Borntraeger, Berlin, 1921).

[2] For an exposition of this theory by Professor Wegener himself, see DISCOVERY, vol. iii, No. 29.

[3] The main exceptions (e.g. Altai and other Central Asiatic block-mountain systems) are more apparent than real. (Vide infra.)

though critically, the results of many investigations and creates a higher synthesis of his own. Old facts appear, but in a new light ; halting half-truths gain a new relevancy and live in a larger and wider meaning. The conception is so vast in scope and involves such a universe of detail that here we can give the merest outline, though no outline can do justice to it.

number of relatively firm blocks separated from each other by zones of less solidified and more plastic material. The geological history of the earth is occasioned by the interaction of these two fundamental elements.

The blocks are to be thought of as great table-like expanses, of irregular outline, worn flat [1] through age-

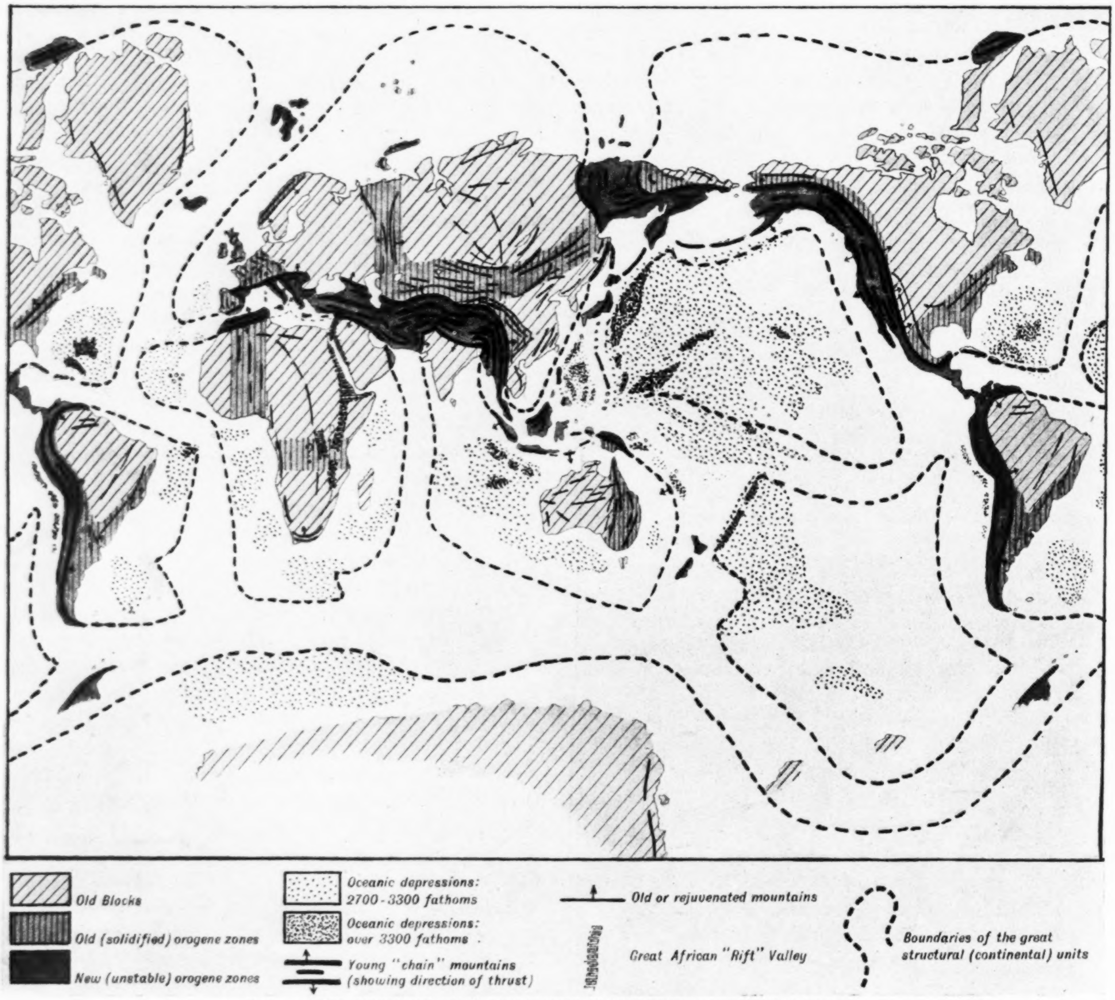


FIG. 1.—MAP SHOWING MAIN STRUCTURAL FEATURES OF THE EARTH.
(*Adapted from L. Kober : " Der Bau der Erde.*")

long erosion. They must lie at approximately one general relative level which is (for their surfaces) very nearly the mean general elevation of the land-surfaces of the globe. The Russian, Siberian, Australian Tables and the Canadian Shield are examples. These old blocks are composed of intensely crumpled,

The dominant cause of movements of the earth's crust is earth contraction due to earth cooling. Other causes (astronomical, geophysical) undoubtedly operate, but they are neither so constant nor so general. Other causes, again, are derivative, secondary, or later results of the great primary cause, shrinkage.

When it emerged from the astronomical into the geological stage the earth had a crust composed of a

[1] Really *convex*, according to the curvature of the earth's surface.

crushed, and compressed materials as foundations, with, on top, relatively thin layers of flat-lying sediments. They form the permanent cores of the continental masses.

Compared with them the plastic zones are, in their extended form, 3,000 km. (1,800–1,900 miles) broad, shallow depressions (geosynclines) filled with sea. Compressed they appear as zones of "chain" mountains having a fairly uniform width of 1,000 km. (620 miles). The Atlantic is probably an instance of such a zone in its hollow (geosynclinal) state; the Alpine-Himalayan mountain-band is a young example of the compressed type. These zones wind sinuously around the continental blocks and every block is completely ringed in by such zones. (See map.)

Formation of Mountain Zones

As the earth contracts the blocks are brought closer together. By their nature and position they have little choice of movement. At first they will draw together in one and the same horizontal plane. They are the active agents, exerting pressure. The brunt of their onset must be borne by the plastic zones. These we must think of at first as in their hollow (geosynclinal) stage, sea-filled and having floors weighted (in all probability) by vast masses of heavy igneous rocks. Also, as great masses of debris from the surrounding lands keep gravitating into them (especially around their edges) their floors keep sinking and deepening and encroaching by dragging down the continental margins.

When pressure is applied this deepening process is accentuated, and it appears to go on until a depth is reached where the temperature, the plasticity of the rocks, and the thinness of the earth's crust at last permit the magmas or underlying fluid strata to force their way up. The process is then reversed: pressure continues and the floor starts to bulge and buckle. The first bulging will take place in the middle of the trough and approximately along its axis (i.e. parallel to the sides of the inpressing blocks). The seas will now begin to be forced out and their encroachment on

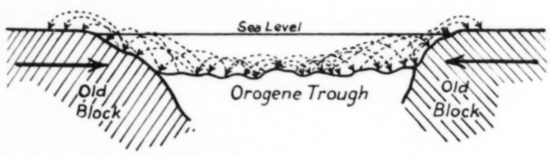


FIG. 2.—THE "PRESSING OUT" OF AN OROGENE TROUGH.

the lands (see above) will be accentuated. As pressure continues other ridges form on the floors of the trough, parallel to the original bulge and extending outwards on either side from it. If there are any harder lumps in the floor they will serve first as occasions and then as the cores of the growing folds (as a dead camel may cause a sand-hill). The blocks press in, the ridges press outwards. Pressure intensifies: the ridges jostle, mount up, push over one another, press some up and out, others in and down, in the search for room and still more room. The deeper and more compressed

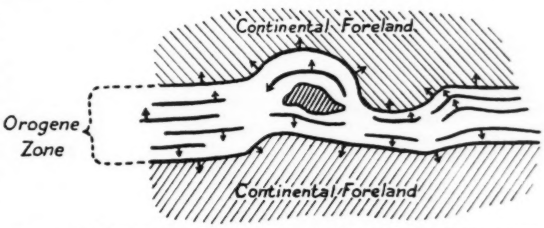


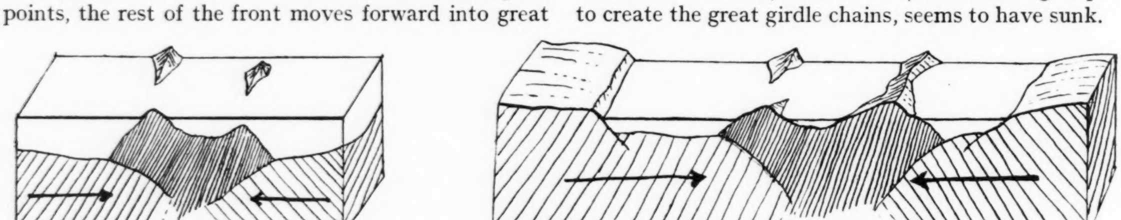
FIG. 3.—DIAGRAM TO SHOW MOVEMENTS IN OROGENE ZONE.

parts are more plastic and serve as gliding planes for the more refractory materials above. The trough is now truly an orogenic zone, a zone giving birth to mountains. Ridge mounts on ridge, and above the shallowing out-flooding seas rise peaks, island rows, island chains, archipelagoes. Then up the inclined planes formed by the continental margins on either side press the ridges, layer thrusting over layer, advancing against the solid land like great frozen waves, their steepest "breaking" faces always in front (outwards). Last of all the whole system is pressed up high and dry: the geosyncline is "pressed out"; it is one-third of its original breadth; it has become a zone of mountains. (Figs. 2–6.)

These mountain zones are eloquent of their origin. Their materials reveal their birthplaces—the shallow, deep, or abysmal seas or the deeper rock zones underlying these. Their structure, infinitely complicated by reason of their history, can generally be unravelled, and this structure is most striking.

Every orogene zone is two-faced. It is as though two giant armies had advanced, back to back, each against an onpressing continent, and each had been frozen where it stood. In the front line are the tallest aggressors frowning abruptly out upon the lands. Where they tread the plains subside, and the Himalayas, the chains of Iran (and many others) are fronted by deeps (Ganges Valley, Persian Gulf, Mesopotamia). The line of advance may be in any direction of the compass, but always it is against the continental block. (See Fig. 3.) Sometimes the advancing giants shovel or push up the land in front of them, and then they are confronted by a shelf-like plateau (Colorado Plateau). (See Fig. 6.) Where the great blocks press hard together, there is intensest distortion and a knot (Pamirs; Armenian Knot); where the pressure is less intense, there are intermont areas, generally plateaux (interior Asia Minor; Thibet). These, having been forced up from the trough floors, are

mostly of heavier materials, and, when the pressure is relaxed, they may subside and form basins (Hungarian Plain).[1] Where the advance is unopposed, it is in line (Pyrenees, Caucasus); where it is held up at points, the rest of the front moves forward into great betray the stresses which the continental block has suffered. (See Asia on map, Fig. 1.) Sometimes even a whole block seems to be depressed or elevated: in the Pacific a block (or two blocks), after having helped to create the great girdle chains, seems to have sunk.



FIGS. 4 AND 5.—KOBER'S DIAGRAMS ILLUSTRATING THE PRESSING UP OF THE OROGENE TROUGH INTO ISLANDS AND ISLAND CHAINS.

arcs [Aleutian, Japanese (East Asian), Carpathian, Dinaric, Tauric arcs].

Concretion of Continental Masses

Though stiff and unyielding, the Old Blocks do not come off unscathed. Comparatively free from the volcanic and seismic travail which marks the birth and death of mountains, they yet buckle, crack, tilt, and sag under the tremendous strain. Every block is ringed round by an orogenic zone, and exerts and suffers pressure from all sides. Doubtless the incidence of the pressure is unequal both in place and time, and mountain zones—or even single mountain chains—must not be thought of as rising or sinking simultaneously and evenly always and all over the globe. Nevertheless, the great tectonic disturbance lines of the continents—the lines of new, old, rejuvenated mountains, of scarps and fracture-valleys—are ranged concentrically around the continental blocks, the most violent around the edges and fading away gradually, like ripples, inwards so that the hearts of the continents remain almost unmoved. Such dominant lines, by their insistence and their compromises, clearly

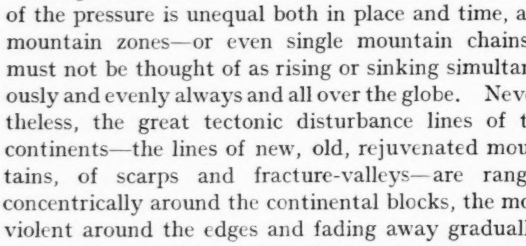


FIG. 6.—KOBER'S DIAGRAM SHOWING (1) THE FORMATION OF A TYPICAL OROGENE MOUNTAIN SYSTEM; (2) THE PUSHING UP OF THE EDGE OF THE CONTINENTAL BLOCK UNDER PRESSURE (COLORADO PLATEAU).

[1] Kober points out that in the great Mid-World (Mediterranean) Orogene System these intermont blocks sink steadily, along with the sinking of the whole mountain system, as we go westwards from its highest part in Central Asia. Thus Thibetan Plateau: average elevation c. 12,000 ft. (cf. *Roof of the World*); Persian Plateau: c. 6,000 ft.; Asia Minor Plateau: c. 3,000 ft.; Hungarian Plain: c. 300 ft.; West Mediterranean Basin: below sea level.

Still, in spite of temporary flooding and submergences, whole or partial, the blocks are permanent elements in the earth's crust. They are continental cores, units from which continents are built. For the last fate of a geosyncline is to be permanently "pressed out," "landed," to become a rigid mountain zone soldering two blocks together. Thus Eurasia is compacted of at least three blocks permanently concreted and, in spite of the superficial flooding of the Mediterranean area, it is likely that Africa also is now finally cemented to Europe.

Subsidence of Mountain Systems

But this happens seldom. The materials squeezed up from the geosyncline are relatively loose, and they are forced up to immense heights. They therefore tend to settle. Also, though for the most part relatively light, they represent in the mass an enormous weight. They are piled up on the continental margins, and these, unequal to the strain, sag. The whole orogene structure is, in fact, unstable, as the vast ruins of water-logged mountain systems, especially along the continental margins of the world, attest.

Thus it comes that the seas, which were sent flooding out far and wide by the steady rise of the mountain zone, contract again and drain back as the continental edges—and, indeed, the whole orogene system—subside. This subsidence is due ultimately to continuous earth contraction. We witness the rebirth of an ocean. Spent, as it were, by its mighty effort, the mountain zone sinks back and in its place is a trough of the sea. Along with it it has carried (to various depths) large portions of the surrounding continents, and the existing land-masses are little more than cores, stiff kernels, of much larger structural units. [See Fig. 1 (map)]. On the floor of the new oceanic geosyncline are preserved at least the vague lineaments of the orogenic zone, its 1,000 km. broad highland, its great frontal deeps, and in addition the great flanking hollows caused by continental subsidence. (See Atlantic on map.)

This, then, is the life-cycle of the great earth synclines—first oceanic troughs, then mountain zones, then troughs again. The last fate, as we have said, of the geosyncline is to become rigid and dead,[1] the cement of continental blocks. The world is probably now in a geosynclinal stage, and at least two, and probably three, cycles such as have been described make up geological history.

The plastic zones show throughout the ages a remarkable permanence of position. Mountains arise where mountains have stood, and oceans repeat oceans. The new mountain zone swallows up the old, builds upon the foundations, and with the materials of the old, and where this is not completely the case the old worn-down stumps are awakened, pressed up again by the new movements into life. Thus while the continents possess the permanence of stability, the plastic zones possess a permanence of change.

An Epoch-making Theory?

If Kober's theories are substantiated, many current notions will have to be revised. The great (hypothetical) land-bridges between South America, Africa, and Australia, between Africa and Europe, will be heard of no more.[2] Many theories as to detailed features of the earth's structure (e.g. those concerning the great Central Asiatic mountain-systems, the great African Rift Valley, the Atlantic Ocean) will need modification. Into these we cannot enter here. Nor shall we indicate the larger inferences drawn by Kober as to the general structure of the earth, except to say that he arrives at an octahedron, that is, a solid figure contained by eight faces, of which the flat faces are not the oceans[3] but the great land masses. Interesting as these speculations are, they must probably await the establishment of their premises.

It is possible that Kober's book marks an epoch: that in its field it represents a Newtonian achievement. Kober himself is fully aware of the incompleteness and insecurity of much of his evidence, but this makes his confidence the more impressive. Critics will perhaps think his building-plans outrun his materials, that construction has been pushed to insecure heights. Kober himself regards his book as an essay, and hopes it will stimulate investigation. This, it is safe to say, it will do. If, like Kober's own orogene system, his theory sinks back into the great geosyncline of oblivion, none the less it will have been a splendid achievement of intellect. We strongly suspect that it will not sink back, that it will become the cement of continents of knowledge.

[1] Except that, as pointed out below, such "congealed" orogene zones are peculiarly liable to fracture, to be reawakened by pressure in later ages.

[2] Kober is not unmindful of palæontological evidence, but he is summary in this respect. We surmise that he will have ultimately to reckon seriously with the biological aspects of his theories.

[3] In the well-known "tetrahedral" theory as expounded by Green, Gregory, and others, the flat faces of the hypothetical tetrahedron are the *oceans*.

*

On Ford Cars to Siwa Oasis

By Major W. T. Blake

THREE thousand years ago the oasis of Siwa was one of the most famous places in the world. Now it has lost its fame, and is indeed unknown even by name to the majority of people, but in interest and beauty it still retains its position. Rock tombs containing mummies, beautiful date and olive groves, the ruined temple of Jupiter Ammon, hoards of buried treasure and lost emerald-mines, all contribute to the interest of Siwa, whilst the people themselves are of the Senussi breed, the most fanatical of all Mohammedans, for it was here that Sidi Mohammed Ben Ali, the founder of the sect, settled in 1838, making it his headquarters.

Owing to its position, over 200 miles from the sea and about 400 miles west of the Nile, and to the fact that it is thus surrounded by the inhospitable desert of the Sahara, it has long remained inaccessible to the traveller. From Alexandria or Cairo it is a fifteen-day journey by camel. Now, the coming of the aeroplane and the Ford car have altered matters, and it was by Ford that I recently made a journey across the desert to this remote oasis.

The Recently Formed Desert Touring Club

In Egypt an organisation has been created called the "Desert Touring Club," which has as its object the exploration of little-known parts of the desert by means of Ford cars. The journey to Siwa was the first big trip that was undertaken. The party consisted of nine people, all, with the exception of myself, residents in Egypt, and set off from Alexandria in three Fords of standard type, except that the bodies had been removed and replaced by shallow platforms. Each car carried three people, petrol for 1,000 miles, water, food, arms, and camp equipment. On the second stage of the journey a further addition was made to the party in the shape of Suleiman, a Bedouin guide provided by the Government authorities, to help the expedition across the open desert.

We left Alexandria at dawn, making for Mersa Matruh, some 200 miles west along the African coast. This spot was one of Cleopatra's favourite resorts, and

the ruins of her palace are still to be seen there. Up to this point the journey was comparatively simple, as a clearly defined track known as the Khedevial Road runs the whole way. In most places the going was fair, and by six o'clock the expedition reached Matruh, having travelled a total distance of 310 kilos in eleven and a half hours, including halts made for lunch.

This part of the expedition was made over comparatively uninteresting desert, as at no time were we more than about ten miles from the sea, and in most places scanty vegetation was present. From time to time we passed grazing herds of camels, or an occasional Bedouin encampment, whilst the glistening white bones of camels which had fallen by the wayside when travelling through the desert showed us that we were on a regular caravan route.

The Journey South

Next day we were up long before dawn to prepare for the 250-mile journey south over the open desert. This time it was no question of crossing "tame" desert. Once the littoral had been left behind and the escarpment climbed the scanty camel-thorn grew even scarcer, and soon we were in the vast expanse of boulder-strewn desolation, with nothing to be seen except rocks of all sizes, and occasional eminences topped with cairns as landmarks to Arab caravans. Skeletons of fallen camels grew more numerous, their bones glistening whitely by the *mashrabs*, or camel tracks. Occasional piles of stones with spaces cleared in front of them marked the graves of Arabs who had died in the waterless desert.

Our guide, Suleiman, brought us along without pause, such slight indications as the faint marks of camels' feet in the sand and carelessly placed pieces of stone being sufficient to show him that he was on the right track.

After a time we came out of the stony desert into a series of depressions where salt-pans and mud-flats had formed, and here the going was so good on the excellent smooth surface that the cars went along hour after hour at an average speed of 40 miles per hour.

Towards evening we sighted a line of curiously carved low hills in the distance, which Suleiman informed us were the hills to the north of the oasis of Siwa. We dropped down through the escarpment amongst weather-worn sandstone and entered Siwa town just before dark.

FIG. 1.—ENTERING SIWA THROUGH THE ESCARPMENT.

Appearance of the Oasis

The oasis of Siwa consists of a depression about 72 feet below sea-level, thirty miles long and six miles wide. It is well watered by about 200 wells, and the rich soil produces wonderful olives, perhaps the best dates in the world, and apricots, melons, grapes, and many other fruits.

We slept that night on the Hill of the Dead, a mound covered with rock tombs, most of which had been opened by the Siwans in order to obtain the stone sarcophagi, which they use for the storage of food. From the summit of the Hill of the Dead one obtains

a splendid panoramic view of the oasis, with its palm groves, wonderful blue lakes, and the two villages of Siwa and Aghourmi.

FIG 2.—THE WALLS OF SIWA TOWN.

The houses in Siwa are built upon the face of the rock, one on top of the other, being broader at the base than at the roof, so that the houses have a conical

FIG. 3.—SIWA SHEIKHS AND NOTABLES.

aspect. Mud and palm trunks are the materials for their construction, and doors and windows are just holes made in the walls. Many of the houses interconnect, and narrow passages winding in and out form the roads. Goats, sheep, and chickens share the houses equally with the human inhabitants, and the smell exuding from the houses is excessively powerful. The houses of the sheikhs and notables are distinguished from those of the ordinary inhabitants by having broad bands of whitewash painted across the front.

Aghourmi, a village about two miles to the east, is smaller than Siwa, but built on the same plan, or rather lack of plan.

Camels cannot live in Siwa owing to the existence of the "gaffar" fly, so that donkeys are the chief means of transport, and they, with goats and sheep, abound.

The Natives and their Customs

The people of the oasis number a little over 3,000, but are dying out through intermarriage. They are not of Arab stock, but seem somewhat allied to the Berbers. It has been suggested that they are the descendants of the expedition sent out from Egypt by Cambyses the Great, which expedition never returned to the Nile Valley. A disease known as Siwa fever, of malarial type, is further helping in the destruction of the population.

Strangely enough, many of the men are physically fine, heights of 6 feet 6 inches being common, and the build big in proportion. Some of them have fair hair and blue eyes. Though Senussi, they are very pro-British—possibly as a result of the war, when Ford cars and aeroplanes first appeared in this fanatical spot, which had previously been untroubled by Europeans.

Siwan marriage customs are free and easy. The people marry very young, and as a rule, by the time a girl is eleven or twelve years of age she has been married and divorced three or four times. Generally speaking the inhabitants are very punctilious about the question of divorce, carefully divorcing one woman before they marry the next, though in a lifetime a man will frequently marry from thirty to forty wives. Needless to say, the birth-rate is low.

On the night before the first marriage the maidens bathe in a well set apart for their use. It is a beautiful palm-fringed pool about 20 yards across and 40 feet deep, from the bottom of which water bubbles up, overflowing through an outlet into an irrigation brook. It is faced nearly to the top with blocks of stone, the work probably having been done from three to four thousand years ago.

Wives, whatever their station, only cost 24*s.* each, so that there is small wonder that the Siwans make frequent changes. Probably, however, 24*s.* represents a large sum to the Siwan, for on my asking the sheikh if there were any wealthy men in the place, he gravely replied that there were several exceedingly rich men, possessing fortunes of quite £1,000 each !

One of the social customs is that when a woman calls on another she wears all the clothes she possesses, and during her visit discards them one by one, placing them in a heap at her side, in order to impress her hostess with her wealth.

As regards food, the Siwans eat anything, but have a decided preference for dogs, cats, rats, and mice. It is indeed impossible to keep a dog or a cat to deal with the hosts of rats and mice, as they so soon disappear into the cooking-pot.

FIG. 4.—RUINS OF TEMPLE OF JUPITER AMMON.

The Ruined Temple of Jupiter Ammon

The principal building of interest in the oasis is the ruined temple of Jupiter Ammon. This was founded by priests from Thebes in 1385 B.C., or 200 years before the oasis was colonised by Rameses III. Siwa was then known as Ammonia, and after the temple was built it began to gain fame as the home of an Oracle. So famous did the Oracle become that the Athenians kept special galleys to convey questions to it for solution, their expeditions coming by sea to Mersa Matruh, and thence over the desert by camel. In 331 B.C. Alexander the Great visited Ammonia to

inquire into his mysterious origin, and as the Oracle intimated that he was of divine birth, he left, after offering gifts of tremendous value to the temple.

The Oracle was made in human figure, with a ram's head, and communicated its decisions to the priests by means of tremulous shocks, and movements of the head and body.

In the sixth century A.D. the place began to lose its position, but some twenty years ago a considerable number of ruins still remained. These were blown up by an officer sent out by the Khedive of Egypt in order to provide stone to build his headquarters, and all that now remains is part of a gateway and a few huge blocks of sandstone, covered with Egyptian hieroglyphics.

Immense treasures are believed by the inhabitants to be concealed somewhere in the oasis, and there is no doubt that gifts of tremendous value were brought to the temple of Jupiter Ammon, and probably concealed somewhere by the priests. The sword and seal of Mohammed are also supposed to be concealed somewhere in the oasis.

Rock Tombs

Rock tombs abound in the oasis and in the hills in the vicinity. Comparatively few of these have been opened, and there is every possibility that interesting finds might be made if excavations were carried out; but great difficulties in the shape of transport would be encountered before work could be attempted. Emerald-mines also exist in the neighbourhood, though their position has long since been lost. From time to time, however, Siwans discover stones in the ordinary course of their agricultural labours.

The "Desert Touring Club" returned from Siwa in much the same way as it had set out. Throughout the journey the cars ran splendidly, the only breakdown of any nature being the fracture of a low-tension wire, which was repaired in about ten minutes.

It is not a journey to be attempted lightly or by those who value their own comfort, for by the time we returned to Alexandria we were sore with sand and sun, our faces were skinned, and hands, arms, and legs blistered by the heat. Food, too, was necessarily of the roughest nature, but nevertheless the journey was one of the most interesting I have ever undertaken, and was worth all the discomforts of the trip.

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Suspended Animation—II

By Sir Arthur E. Shipley, G.B.E., F.R.S.

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Fish

A VERY considerable number of vertebrates (animals with backbones), for instance the *Carp*, bury themselves in mud during the winter and live with life in abeyance. This may possibly account for the great age to which carp live, namely from fifty to one hundred years or even longer. They are very prolific, and like all long-lived fish they grow slowly, but attain a considerable size, running up to 50 lb. The carp is really a native of Persia and China, and was introduced into Europe in the middle of the thirteenth century. It was known in England towards the close of the fifteenth century.

At the very top of the fishes are animals which have almost turned into AMPHIBIA, for they have lungs as well as gills. One of these, *Protopterus*, lives in the western half of Africa and spreads through the whole of the tropical regions of that country. During the dry season, which in this part of the world is in the summer, these animals, living in shallow water which periodically dries up, retire into the mud and make a kind of clay ball which is lined and held together by a secretion of slime. These clay balls, if dug up unbroken, can be transported about the world, and if placed in tepid water, the capsule gradually dissolves and the fish emerges. Another two-lunged fish of the same family, *Lepidosiren*, occurs in tropical America, and it also is stated to make mud capsules. As these fish mostly go into retreat during the summer, they are said to æstivate and not to hibernate.

The Carp family, as has been already mentioned, hibernates, but not completely, and the same is true of certain eels. None of these fish fall into a complete state of coma, as reptiles and mammals are apt to do, but all their living functions are reduced and lowered. They cease to feed, they cease to look for food, and retire into holes and crannies where they are sheltered from their enemies. In India certain fishes can survive embedded in the mud for several years, and ponds which have been dried up for some time become rapidly crowded with fish when water again enters them.

Amphibia

When we leave fishes and come to the *Amphibia*, the frogs and the newts—animals which live part of their life in the water and part on land—we find that they are creatures which can live for many months without food. In the cooler parts of the world many of these hibernate in the mud; in hot climates they

take up a similar habitat, but that only during the dry season. They can endure a surprising amount of cold, at any rate those of the temperate region, but they will not survive being frozen hard as the carp will. Frogs hibernate generally in masses together at the bottom of ponds, but if reached by prolonged frosts during exceptionally severe weather they succumb. This is especially true of the younger animals, the older being more experienced and more successful in finding safe retreats. Frogs which have just hibernated can stand complete immersion under water for eight times the period which will suffice to drown them during the breeding season. The many and repeated accounts of frogs and toads having been buried for centuries in holes in the solid rock and in coal have never been substantiated and may be dismissed as fables.

Reptiles

Amongst the *Reptilia* anyone who has ever kept a land-tortoise knows that it disappears underground during the winter, and fresh-water tortoises hide away in the banks or at the bottoms of rivers. Snakes and lizards disappear into holes in trees or under stones and dry leaves.

The terrapin, so beloved by epicures in the Southern United States, dig themselves into holes during the winter months, and they do not come out until the spring is well advanced. The so-called box-tortoise, a domestic pet in the United States, becomes very tame; but it must be allowed to hibernate. If kept in a warm house they become fretful in the autumn, refuse all food and drink, and are liable to die unless they can find a cool place to hide away in and sleep for months. If left out-of-doors they burrow into the ground or sometimes hide under a heap of rubbish well out of the reach of the frost. But a warm April day brings them back to life, and then their first requirement is a little drink. The Greek and Moorish tortoises, which are sold from barrows in our streets, and are kept as garden pets, also require to hibernate, and if lured from their winter homes by exceptionally warm days in the early spring, are likely to suffer in health should a cold spell set in, for they are very much less hardy than before they entered into retreat. The gigantic land-tortoises from the Aldabra atoll bury themselves for at least half a year.

Another group of reptiles, the crocodile and alligator, in the tropics æstivate in the hardened mud; they have been known to exist in this state of seclusion for a whole year without food. Tennant, in his well-known work on Ceylon, recalls the story of an officer who, when camping out one night, was disturbed by a curious movement underneath his bed: the movement was explained in the morning by the emergence of a crocodile. Crocodiles will also hide away in mud at the approach of danger, and like many another animal they feign death.

We have mentioned above that snakes and lizards frequently hide away during the colder months, and it is a curious fact that, should a viper be awakened during its winter sleep, its bite is said to be harmless. Whether this is so or not requires confirmation, but I do not propose to try the experiment myself.

Birds

The naturalist of the eighteenth century, even the gifted Gilbert White, believed that certain birds hibernated. The disappearance of the swallow each autumn, of the corncrake, nightingale, cuckoo, etc., was by them accounted for by the idea that these birds hid away sometimes under water, and rested during the colder months. This view has now been entirely given up, as it is now known that they retire to warmer climates during the winter.

Mammals

Amongst mammals many species hibernate in the temperate and colder regions of the world during the winter. The well-known European hedgehogs, often kept as pets in the gardens of Great Britain, are the largest of our native Insectivores and they hibernate completely. Unlike the squirrel, they store no food, but retire into a bed of moss or leaves and roll themselves up into a ball with all their prickles outside, and remain in seclusion until the spring warmth revivifies them.

There is another curious little Insectivore known as the *Tenrick,* an animal possibly allied to the marsupials of Australia and America. They are generally found in the mountains of Madagascar, and during the colder seasons of the year hibernate for a long period. They fatten themselves up during the spring, and in this condition are much sought after by natives as an article of food. About May or June they retire into deep burrows in the ground and do not re-emerge until the following Christmas.

The common raccoon, which is confined to America, is particularly common in the Adirondacks. It hibernates during the severest part of the winter; as Dr. Merriam tells us, "retiring to his nest rather early and appearing again in February or March according to the earliness or lateness of the season."

The same author records that the black bear also "hibernates, although its torpor is not deep, and the time of entering upon the winter repose depends upon the severity of the season and the amount of food-supply. The males will remain active in any weather, so long as they can find abundance of food.

The female is, however, compelled to seek shelter sooner on account of her prospective family. The winter den of a black bear is generally a partial excavation under the upturned roots of a fallen tree, or beneath a pile of logs, with perhaps a few bushes and leaves scraped together by way of a bed, while to the first snowstorm is left the task of completing the roof and filling the remaining chinks. Not unfrequently the den is a great hole or cave dug into the side of a knoll, and generally under some standing tree, whose roots serve as side-posts to the entrance. The amount of labour bestowed upon it depends upon the length of time the bear expects to hibernate. If the prospects point towards a severe winter, and there is a scarcity of food, they 'den' early and take pains to make a comfortable nest; but when they stay out late, and then 'den' in a hurry, they do not take the trouble to fix up their nests at all. At such times they simply crawl into any convenient shelter without gathering so much as a branch of moss to soften their beds. Snow completes the covering, and as their breath condenses and freezes an icy wall begins to form, and increases in thickness and extent day by day till they are soon unable to escape, even if they would, and are obliged to remain in this icy cell till liberated by the sun in April or May."

Although in the south the grizzly bear remains active throughout the winter, in the northern part of its range it hibernates. When during the spring it emerges, it has a habit of standing upright against a tree and scoring the bark with its claws. As it usually stands on a base of 4 or 5 feet of hardened snow, the height of its clawings must not be taken as representing the length of the animal, though sportsmen who tell bear stories very often do so.

But perhaps the best known amongst the hibernating animals are found amongst rodents. Squirrels, as we have indicated above, are but partial hibernators. In temperate climates they retire during the winter into hollows of trees. They bury their stores of nuts, or other food, just beneath the surface of the ground in various caches in the woods, and from time to time awake from their winter sleep to feed.

The chipmunk, as Dr. Merriam tells us, begins to hoard up large stores of food in the autumn, and being the least hardy of the American squirrels, commonly goes into winter-quarters at the beginning of November, not appearing again until the early thaws of February tempt him out.

The marmots of Europe and Asia also hibernate, the Alpine species making large burrows with a single entrance. The burrows end in a large chamber lined with grass, and here, coiled away from the cold, some ten to fifteen marmots may be found clustered together.

One of the commonest children's pets in Great Britain is the dormouse, and as readers of *Alice in Wonderland* will remember, it is a profound sleeper. The dormouse accumulates much fat at the approach of winter, but a warm day will bring it out to eat some of its accumulated store of fat, acorns, beech-nuts, beech-mast, or corn.

One more example. A certain little lemur confined to Madagascar retires into torpidity during the southern winter or dry season. Before retirement, however, it accumulates an immense quantity of fat in certain parts of its body, notably in the tail, which recalls the appendage of the well-known fat-tailed sheep of the Cape, or Middle East. By the time the lemur emerges its tail has resumed its normal dimensions.

We have seen there is a certain progressiveness in hibernation: some animals come to life during the winter and feed, others remain immovable for months. But in all, the vital processes are much weakened and diminished. Feeding and movement are at an end, the heart-beat is limp and the breathing imperceptible. In those animals that hibernate most thoroughly, life is sustained by their absorbing their own fat.

Human Beings

We have said that one of the attributes of living organisms is that they perform certain actions rhythmically at stated periods. One of the most striking of these rhythms is sleep. We have also seen that this sleep, in the case of certain animals, may be not a matter of day and night, but may be prolonged throughout the winter, or in the tropics throughout the summer. There are many cases in human beings where sleep is prolonged into a trance, and for the most part these trances are not within the control of the sleeper. A trance is a sleep-like state which comes spontaneously, and is independent of any poisons, though of course certain poisons produce profound sleep. It is very difficult to arouse a person from a trance. People subject to them are seldom in perfect health. Very often they are slightly hysterical, and in other cases they are anæmic.

As a rule a trance sets in quite suddenly. There is a case of a girl going into a room by herself and being shortly afterwards found in a state of coma which lasted thirty-eight hours. In another case a young woman went upstairs to change her dress, and was found in a state of trance on her bed which lasted for fourteen days. But the most interesting factor about trances is that sometimes they can be produced at the will of the sufferer. In India, where mystery and magic are very prevalent, it has for a long time been believed that certain holy men called "fakirs," who live a life of privation and often of self-

inflicted torture, have the power of voluntarily placing themselves in a state of suspended animation, which lasts for varying periods. At the end of each period they return to life unchanged and undisturbed. It is a common tale of Indian travellers.

Verworn has recorded an instance quoted from Baird, one of the earliest writers on hypnotism, in the following lines :

" At the palace of Runjeet Singh, in a square building which had in the middle a closed room, a fakir, who had voluntarily put himself into a lifeless condition, had been sewed up in a sack and walled in, the single door of the room having been sealed with the private seal of Runjeet Singh. (To judge from the account, the air, as in all such cases, was not absolutely excluded.) In order to exclude all fraud, Runjeet Singh, who was not himself a believer in the wonderful power of the fakirs, had established a cordon of his own bodyguard around the building ; in front of the latter, four sentries were stationed, who were relieved every two hours and were continually watched. Under these conditions the fakir remained in his grave for six weeks. An Englishman, who was present during the whole event as an eye-witness, reported as follows concerning the disinterment, which took place at the end of six weeks : When the building was opened in the presence of Runjeet Singh, the seal and all the walls were found uninjured. In the dark room of the building, which was examined with a light, the sack containing the fakir lay in a locked box, which was provided with a seal likewise uninjured. The sack, which presented a mildewed appearance, was opened, and the crouching form of the fakir was taken out. The body was perfectly stiff. A physician who was present found that nowhere on the body was a trace of a pulse-beat evident. In the meantime the servant of the fakir poured warm water over the head, laid a hot cake upon the top of the head, removed the wax with which the ears and nostrils were stopped, with a knife forcibly opened the teeth, which were tightly pressed together, drew forward the tongue, which was bent backward and which repeatedly sprang back again into its position, and rubbed the closed eyelids with butter. Soon the fakir began to open his eyes, the body began to twitch convulsively, the nostrils were dilated, the skin, heretofore stiff and wrinkled, assumed gradually its normal fullness, and a few minutes later the fakir opened his lips and in a feeble voice asked Runjeet Singh, ' Do you believe me now ? ' "

Many other cases have been recorded by witnesses of established veracity, and rarely cases have been described in Europe. Dr. Cheyne, a well-known physician of Dublin, gives an account of the case of Colonel Townsend. It is so extraordinary that it is worth quoting :

" He could die or expire when he pleased, and yet, by an effort or somehow, he could come to life again. He insisted so much upon us seeing the trial made that we were at last forced to comply. We all three felt his pulse first : it was distinct, though small and thready, and his heart had its usual beating. He composed himself on his back, and lay in a still posture for some time ; while I held his right hand, Dr. Baynard laid his hand on his heart, and Mr. Skrine held a clear looking-glass to his mouth. I found his pulse sink gradually, till at last I could not feel any, by the most exact and nice touch. Dr. Baynard could not feel the least motion in the heart, nor Mr. Skrine perceive the least soil on the bright mirror he held to his mouth. Then, each of us, by turns, examined his arm, heart, and breath ; but could not, by the nicest scrutiny, discover the least symptom of life in him. We reasoned a long time about this odd appearance as well as we could, and finding that he still continued in that condition, we began to conclude that he had, indeed, carried the experiment too far ; and at last we were satisfied that he was actually dead, and were just ready to leave him. This continued about half an hour. By nine in the morning, in autumn, as we were going away, we observed some motion about the body, and upon examination found his pulse and the motion of his heart gradually returning : he began to breathe heavily and speak softly. We were all astonished to the last degree at this unexpected change, and after some further conversation with him, and among ourselves, went away fully satisfied as to all the particulars of this fact, but confounded and puzzled, and not able to form any rational scheme that might account for it."

Readers of the *Master of Ballantræ* will recollect that in his last desperate effort to escape his enemies the " Master," under the guidance of his East Indian friend, went into one of these states of suspended animation. The last page or two is occupied with a vivid account of the efforts of the Indian to exhume the body of his English friend. " ' I tell you I bury him alive,' said Secundra. ' I teach him swallow his tongue. Now dig him up pretty good hurry, and he not much worse.' The frost was not yet very deep, and presently the Indian threw aside his tool, and began to scoop the dirt by handfuls. Then he disengaged a corner of a buffalo robe ; and then I saw hair catch among his fingers : yet a moment more, and the moon shone on something white. A while Secundra crouched upon his knees, scraping with delicate fingers, breathing with puffed lips ; and when he moved aside, I beheld the face of the Master wholly disengaged. It was deadly white, the eyes closed, the ears and nostrils plugged, the cheeks fallen, the nose sharp as if in death ; but for all he

had lain so many days under the sod, corruption had not approached him, and (what strangely affected all of us) his lips and chin were mantled with a swarthy beard." The Master returned for one brief moment to life, and then sank into that eternal sleep which he had simulated for over a week.

Modern Industries—II.

Lime and Whiting Manufacture in Lincolnshire

By R. C. Skyring Walters, B.Sc., Assoc. M.Inst.C.E.

In a previous communication some of the Great Chalk excavations at Barton-upon-Humber were described in connection with the Portland Cement Industry. It is now proposed to describe some quarries, also very large, situated four to six miles south of the Humber. Here the chalk comprises what geologists call the "Middle" Chalk, which is of a very different character from that of the "Lower" Chalk at Barton. The Middle Chalk contains a great deal more flint than the Lower Chalk. The previous article described how the pure, almost flintless chalk was mixed with river mud or clay and burnt to Portland cement at the works erected on the Humber side. But inland, not only are there no facilities for water-transport, but there is little or no suitable clay at the surface, and the chalk is usually full of flint either in the form of smooth nodules, some of which attain a diameter of 3 or 4 feet and are called "Paramoudras," or in the form of regular layers which can be traced all round the quarry.

The origin of *chalk* is now well known ; that is, it is an assemblage of the shells of minute marine organisms and is comparable to, though not necessarily identical with, the ooze or mud found beneath the Atlantic to-day. The origin of *flint* is very obscure. An old geologist once was so hardy as to say that flint was a molten lava that had thrust its way out from the centre of the earth—how it arranged itself in such regular layers was difficult to explain ! Modern geologists and chemists affirm that flint is the siliceous (or sandy) component of chalk which has separated out into layers for some unknown reason ; a recent suggestion being that the whole mass of chalk was once in a state of saturation with a solution of silica diffused through it. The silica separated itself into bands of flint, absent in the "Lower" but becoming more numerous towards the "Middle" and "Upper" chalks. A striking analogy to this theory may be obtained by inserting certain chemicals in a test-tube of gelatine. These chemicals separate out into well-defined rings comparable to flint, those at the middle of the test-tube being near together, while those farther from the middle are farther apart ; the bands being absent altogether at the top and bottom.

Fig. 1.—General view of a "Middle Chalk" quarry.

In Lincolnshire the "Lower Chalk" consists of a greyish-white flintless chalk arranged almost horizontally in beds or layers 50 feet thick. This is divided from the "Middle Chalk" by a band of marl (chalky clay) about 2 feet thick. The "Middle Chalk" is a hard white chalk 100 feet thick with scattered flints and layers of flint-nodules in the upper part. The "Upper Chalk" has only comparatively recently been dis-

tinguished from the "Middle Chalk" in North Lincolnshire, by means of certain fossils which it contains but which do not occur in the lower two divisions. It consists of a hard white chalk, 80 feet or so in thickness, with numerous thin layers of flint.

Fig. 1 shows a general view of part of one of the two

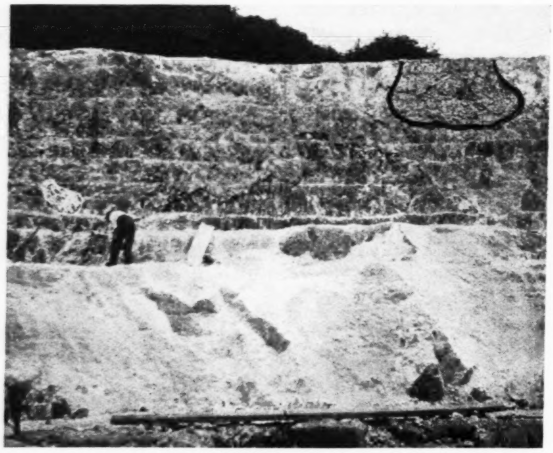

FIG. 2.—VIEW SHOWING METHOD OF WORKING AND EFFECT OF WEATHERING ON CHALK.

great quarries at Melton Ross situate on the main line between Sheffield and Grimsby, which passes between them on a high natural embankment of chalk that has not been quarried. These quarries, each 175 yards long by 100 yards wide and 50 feet deep, have been worked for many years for whiting, and lime for building and agricultural purposes, but the bulk of the output is used for fluxing steel in furnaces.

The chalk, or "Limestone" as it is called locally, is won simply by pick and shovel, and occasionally by blasting. It is quarried out in steps or ledges as shown in Figs. 1 and 2. For making whiting, which is chemically pure chalk, there are pan-mills to grind to a paste the pure white beds of chalk which occur in certain parts of the quarry. The slurry or liquor from the pan-mills is run off into settling-pits, from which the paste is dug out by hand and placed in lumps on shelves in long open sheds where it is dried by the air. A certain waste-product is removed from the slurry before it enters the settling-pits. This product is coarse in grain and cannot be used in the manufacture of whiting, although its chemical composition is identical with that of whiting.

The process is quite simple ; but good raw material such as is to be found in the "Middle Chalk" is indispensable.

The manufacture of lime, and of the purer variety of lime for steel-smelting, is also carried out in brick kilns in one of the quarries. The process consists of burning the chalk (calcium carbonate) into lime (calcium oxide)—the latter, like cement, having the property of forming another hard chemical compound when mixed with water.

The flint quarried is ground for poultry grit.

Fig. 2 shows the manner in which chalk disintegrates when exposed to the atmosphere for some time, the lines of stratification being almost obliterated. This is seen in the top right-hand corner of the photograph, where there is an old trial-hole which was put down to test the nature of the chalk before opening up the quarry. The photograph shows the lines of stratification of the freshly dug quarry contrasted with the disintegrated chalk of the trial-hole put down two years or so before the quarry was opened out.

Fig. 3 shows a large pit one mile south of Ulceby Church or two miles east of Melton Ross whiting works. The character of the chalk here, belonging to the Upper

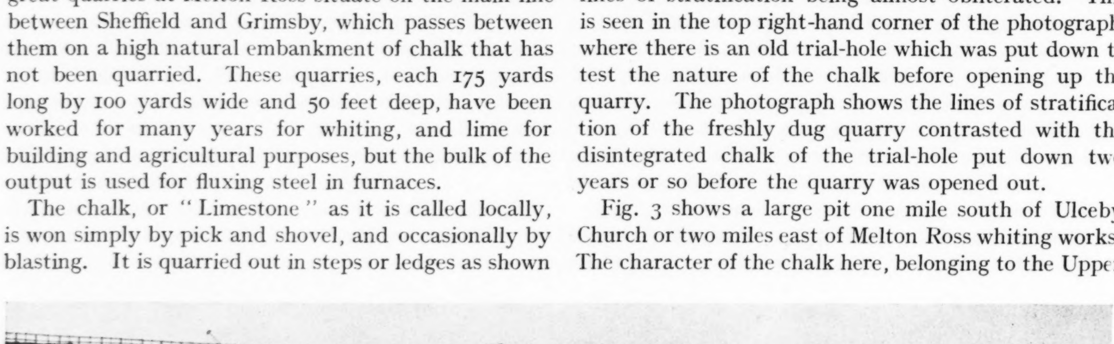

FIG. 3.—GENERAL VIEW OF THE CHALK WITH FLINT "UPPER CHALK" QUARRY AT ULCEBY, USED FOR THE CONSTRUCTION OF IMMINGHAM DOCK.

Chalk formation, is very different from that of the Lower and Middle varieties of Barton and Melton Ross. The chalk contains an abundance of flint which renders it quite unsuitable for the manufacture of cement or lime. The quarry was dug on a very big scale in 1906 to supply hard filling material in the construction of Immingham Dock, and has a face of 300 yards and is 77 feet deep. It consists of:

	Thickness of Seam.		Depth of Bottom of Seam below Surface.	
	ft.	in.	ft.	in.
Light brown loamy clay, boulder clay	7	0	7	0
Chalk	4	0	11	0
Thick seam of flint	1	0	12	0
Hard chalk with at least 5 flint layers 6 in. thick with a *fossiliferous* layer at the base	30	5	42	5
Chalk with 6 thin seams of flint, main working floor	15	4	57	9
Chalk with 2 thin seams of flint with *fossiliferous* layer at base . .	6	0	63	9
Chalk with 7 thin seams of flint 3 in. to 6 in. thick, some of which are pink, lowest working floor . . .	8	0	71	9
Chalk with 2 seams of flint . .	5	3	77	0

Several urchins, typical of the Upper Chalk, found by the writer were identified by Dr. H. L. Hawkins, namely *Hol. Sternotaxis planus* and *Micraster*, sp., low zonal form, and the pretty fish's tooth, *Oxyrhinca mantelli*.

My thanks are due to Mr. G. M. Borns and Mr. W. H. Wicks for much help in the preparation of these notes.

From the Vague to the Concrete in Science

By D. Fraser Harris, M.D.; D.Sc.

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THERE are several examples in the history of science where an idea at first represented by some purely metaphorical expression became in course of time a concrete existence. Most of the sciences have instances of it: one meets at first with a notion, often of the vaguest, a principle, a property, a potentiality for something or other, and one ends with a substance, a species of matter, tangible and ponderable; the notion has become incarnated.

Examples in Inorganic Chemistry

Inorganic chemistry offers us an excellent case of this process. When Lavoisier was working out the character of the substance we now know as oxygen, he had not isolated oxygen by a stroke of genius and then proceeded to study the properties of the new chemical product; the history of its discovery is far otherwise. Acting on some hints given him in October 1774 by the Englishman, Joseph Priestley (1733–1804), Lavoisier (1743–1794) came upon what he soon named as the "principle of acids" or the "acidifying principle": his own words written in 1777 were—

> "I shall therefore designate dephlogisticated air, air eminently respirable, when in a state of combination or fixedness, by the name of acidifying principle or, if one prefers the same meaning in a Greek dress, by that of oxygine principle."

Here it is a "principle," something which combines with metals when they are calcined or burned in air; it is that something which to Lavoisier seemed essential in acids, that which produced acidity, the oxygine principle. Its later and more familiar form of "oxygen" is better etymologically. Now that which was a principle in 1777 became, a hundred and twenty years afterwards, a visible, tangible entity. The "principle" of 1777 had become a substance by 1897; the metaphor had become an actuality.

The word "gas" is itself an example of what we are thinking about. "Gas" and "blas" were arbitrary words coined by van Helmont in 1630 to signify two things in physiological chemistry: the one, carbon dioxide, the other, some super-material power or agency which was supposed to direct the activities of living matter. In the course of time not only carbon dioxide, but many other gases, became known, and ultimately were isolated and even made visible in the liquid state; whereas "blas" is still the metaphysical concept it ever was. "Gas" has literally materialised because it referred to a form of matter; "blas" has never got outside the concept or brain of the philosopher.

Not all chemical concepts have been equally fortunate in leading to actual and individual chemical substances; phlogiston, for instance, denoting, as it did, no reality, is phlogiston the concept still. The principle of heat, phlogiston, was supposed to leave a body when it was burned; the theory of Stahl (1697) asserted that heat was a thing—a thing which could depart from a body and leave it lighter than previously when it was cold. Now this, as a conception, is quite satisfactory, but as it is not true in fact, phlogiston never materialised; it was never isolated from matter because it never existed in matter. Phlogiston was as barren as "oxygine" was pregnant. To-day Priestley and Lavoisier could be presented with kilogrammes of the "oxygine" principle, but not a milligramme of phlogiston could be extracted for Stahl, because oxygen is a substance, but heat is a mode of motion.

The Case of the Molecule

Chemistry furnishes us with another example of the thing in the mind, becoming ultimately a thing

in the outer world of matter, namely, the evolution of the conception of the molecule. The atom as Dalton conceived it in 1804 was the smallest portion of matter which could enter into chemical union with some other similar substance, or could replace some other atom in a compound, thus forming a new compound. In course of time the Italian chemist Count Amedeo Avogadro (1776–1856) became convinced that there must be bodies composed of two, three, or more atoms —compound atoms, in fact—which were able to exist in a state of freedom, in gases for instance. Avogadro therefore coined in 1811 the word "molecule" (the diminutive of the Latin *moles* = a mass) "as a term of convenience" to express the conception he had of the smallest portion of matter able to exist in a free state.

Dalton's atom is the unit of chemical activity, Avogadro's molecule is the unit of physical structure. For many a day after Avogadro's time, the atom and the molecule were still "terms of convenience": neither had been seen; but to-day both atoms and molecules are believed in as real existences; and as for molecules, they have been weighed and measured.

The author of a recent textbook of chemistry writes thus: "The Brownian movement has revealed to us bodies intermediate between ordinary particles and single molecules, and has enabled us to estimate the actual weight of molecules. . . . There is thus no question that molecules and atoms are real." Not only so, but the physical chemist can calculate the number of molecules in a given volume of gas. Thus the conception of the molecule has been discovered to correspond to a real, external, physical entity.

Fermentation and Digestion

No better example than that of the ferments could be given of a notion becoming in course of time a substance isolated and tangible. Fermentation, the totality of changes produced in digestible, coagulable, or putrescible material, was for ages believed to be inscrutably mysterious. It was made the subject of debate between the iatro-mathematicians and the iatro-chemists of the seventeenth century, but neither school really understood it.

Digestion, the great fermentative process in animals, was confused not only with putrefaction, but with boiling and with the effervescence of gas in chemical operations. Stahl (1660–1734) saw in digestion the direct activity of the soul or anima which, he held, permeated every tissue and endowed it with its special powers. The chemistry of it all, however, was unknown; the very conception of a ferment, a substance produced by living matter but not itself living, had not as yet emerged from the mental confusion.

Van Helmont (1577–1644), Sylvius (1614–1672), de Graaf (1641–1672), and Haller (1708–1777) all groped for it, but it was not until the work of René Antoine Ferchault de Réaumur about 1750 that any true notion was held as to digestion being a form of fermentation. Réaumur was the first to obtain gastric juice in an approximately pure state and to attempt digestion with it outside the body. Spallanzani, the distinguished Italian naturalist at Pavia, began where Réaumur left off, and discovered in 1777 that digestion was by no means putrefactive, but was apparently due to some "solvent power" or "active principle of solution" in the gastric juice. Then, by degrees, as physiological chemistry improved its methods it obtained finer results, and at last "the solvent power" or "principle of solution" in the gastric juice was isolated in 1862 as the white powder, pepsin, a name which had been given by Schwann to the "active principle" as far back as 1836. Soon other ferments were either isolated or obtained in solution, and to-day in our laboratories we store in glass bottles a dozen or more of those actual substances which are the modern representatives of the "principles of solution" of the early researchers. The vague has become definite, the conceptual power or property has become the material substance or entity.

Diseases of the Thyroid and Pituitary Glands

The story of the isolation of the internal secretion of the thyroid gland—the body covering the projection in the throat called "Adam's apple"—is very similar. Physicians had come to learn that if this gland was in a state of inactivity in early life the condition of imbecility or cretinism was the result, and if the gland became inactive in later life a curious disease called myxœdema was produced. In this latter condition the skin was tumified and the brain showed degenerative changes which were reflected in the loss of energy and in the general lethargy of the patient.

It was also believed that, when the thyroid gland became over-active, a distressing disease, exophthalmic goitre, characterised by a rapid heart-heat, was the result. In course of time it was discovered that cretinism and myxœdema were both ameliorated or cured by administration of thyroid gland; and, on the other hand, exophthalmic goitre was relieved by excision of a portion of the thyroid. An internal secretion was assumed to be absent or greatly diminished in cretinism and myxœdema, but increased in exophthalmos. In due time, at the close of 1914, a soluble, stable, crystalline substance named thyroxin was isolated and found to do everything that thyroid gland itself would do. Three and a half tons of pigs' thyroid have been made to yield only 36 grammes of the hormone thyroxin. Another surmise had been materialised, incarnated, objectified.

The pituitary gland at the base of the brain has also been credited with an internal secretion of wide-reaching power. If its secretion is deficient in early life, a dwarf-like condition is the result ; if, conversely, it be excessive, the individual grows up a giant (gigantism). If the activity of the gland is deficient in adult life, a distressing and progressively fatal disease, called acromegaly, is induced. In this condition the bones of the face, hands, and feet become hugely overgrown.

From the posterior part of the pituitary body there has been extracted a substance (pituitrin) which is a powerful stimulant to the uterine muscle, and as such is daily used by obstetricians.

Insulin and Diabetes

Within the last two years another of these internal secretions, or hormones, has been identified and isolated. The term "insuline" had been suggested by Sir Edward Schafer before 1916 as the name of the substance which was manufactured by the islands of Langerhans in the pancreas and which, carried by the blood to the tissue, enabled them to oxidise the sugar of the blood to carbon dioxide and water. When, owing to disease of the pancreas, this internal secretion was deficient or absent, sugar accumulated in the blood and was excreted by the urine—a condition known as diabetes. At Toronto University a number of workers, directed by the head of the Department of Physiology there, have recently succeeded in extracting from the islands of a healthy pancreas a substance which, if injected into the blood of a diabetic animal, will clear it of its blood-sugar and greatly prolong its life. When administered to human beings suffering from diabetes the effects have been equally striking.

At the close of 1922 more than fifty diabetics had been immensely benefited and had their lives prolonged by this insulin treatment. Diabetes is most fatal in young children. There are children living to-day who some months ago were moribund from diabetic coma.

Insulin has been captured and found incarnated in the pancreas. From this it has been extracted, purified, and bottled.

The Black Death

Another excellent example of the rendering definite what was before of the vaguest is the recent discovery of the cause of plague, the pestilence, or Black Death. In the fourteenth century the great surgeon of Avignon, Guy de Chauliac (1300–1370), attributed the plague to a conjunction of the planets Saturn, Jupiter, and Mars in the sign of Aquarius on March 24, 1345. About the same time the Jews in Germany and Switzerland were suspected of poisoning the wells and were in consequence persecuted and massacred. In the fourteenth century the medical faculty of the University of Paris was asked to deliver an opinion on the nature and origin of plague, but a very great deal that it promulgated was absolutely fatuous as regards protection or cure. One thing only was recommended that is interesting in the light of to-day, namely the fumigation of houses by the burning of aromatic herbs and woods. Only as recently as 1894 was the *vera causa* of the Black Death, one of mankind's most terrible traditions, discovered by two Japanese doctors, Yersin and Kitasato, and named the *Bacillus pestis*. It was soon isolated in pure cultures, grown in artificial media, and its toxins and antitoxins became chemical entities.

The source of the plague was shown to be a bacillus, a most minute vegetable parasite, which growing in bodies of certain animals, rats and other rodents, could give rise to a virulent poison (pestiferin) which was carried to all parts by the circulating blood. It was further shown that man became inoculated by fleas which had been feeding on the bacilli containing blood of rats. Thus were revealed the several links in that long chain which had the *Bacillus pestis* at one end and man at the other. It took mankind three thousand years to come to a knowledge of the truth regarding the cause and manner of the spreading of plague, to a knowledge of that chain of cause and effect which connects microbe and man in the dire relationship of the plague-stricken.

Influenza

Very probably some of the great epidemics of the Middle Ages were in reality what we now call Influenza, its very name being only the Italian for influence, a something inscrutable but omnipresent, mysterious in the last degree. The usual expressions were in vogue—it was a corruption in the air, a miasma, an exhalation, and so on ; until in 1892 the bacteriologist Pfeiffer isolated the organism of influenza and named it the *Bacillus influenzæ*. Not the air, then, but the microscopic fungi it may hold for evil influence, constitute the true cause of influenza. The influence is now materialised, nay, indeed, is isolated and sealed down under glass for the inspection of trained eyes. Thus by the microscope are these deadly powers of the air one by one distinguished from each other and identified each by its particular malignancy.

The story of the discovery of the telescope, how it was bound up with that wonderful emancipation of the human spirit from the thraldom of mediæval ignorance and the hatred of scientific light, has been told us by many learned men ; but I venture to think that the discovery of the microscope, which still awaits its poet, was one fraught with many more beneficent results for humanity. By its scrutiny the invisible

but actual sources of most of the scourges of mankind have been discovered.

We may say in conclusion that the principle of the incarnation of ideas, of the realisation in the world of substance of what had been vaguely foreshadowed in the world of mind, is a process which has gone on in science as surely, if not perhaps so conspicuously, as in art. The artist succeeds more or less perfectly in incarnating his ideas of beauty in stone, pigment, words, and sounds ; but it is sometimes the privilege of the scientist to extract, as it were, the concrete from the abstract, to isolate in material form what was once only a notion, a suggestion, a forecast.

The Respiration of Insects

By I. Leitch, D.Sc.

To the ancient physiologist the problem of respiration had not presented itself as a problem. To Aristotle it was very simple. "For the fact is, some aquatic animals (as fish) take in water and discharge it again, for the same reason that leads air-breathing animals to inhale air ; in other words, with the object of cooling the blood." Leonardo, the greatest biologist between the Greeks and modern times, had perhaps a glimpse of the fact that the process is not so simple. "The air which is inhaled by the lung continually enters dry and cool, and leaves moist and hot. But the arteries which join themselves in continuous contact with the ramifications of the trachea distributed through the lung are those which take up the freshness of the air which enters such lung." But it is only to the biologist of the last few years that the immense complexity and exquisite refinement of the process have become plain.

The nature of the problems involved and the manner of dealing with them are well illustrated by the latest work on insect respiration from Professor August Krogh's laboratory in Copenhagen. Let us take the problem in its threefold aspect : (1) the nature of the demand for oxygen in insects ; (2) the available supply of oxygen ; and (3) the means by which supply is adapted to demand, or, as must happen when the supply falls very low, demand adapted to supply.

The Demand for Oxygen

With regard, then, to the demand for oxygen, there are two factors of prime importance, that of activity and that of temperature. Any animal or part of one, such as a gland or a muscle, will consume much more oxygen when active than when at rest. When all voluntary muscular activity ceases, and other processes are reduced to a minimum (digestion and absorption, for instance, are not taking place), there will still remain a certain residual consumption of oxygen which will just be enough to maintain a completely quiescent state of life. Now the amount of oxygen required by any animal in this resting state is of great importance. The fire of life is burning low ; it is "damped down" to the lowest practical limit. If we can measure the oxygen consumption of any animal in this resting condition, when its metabolic processes—that is, the processes of using the living tissues and their stores, and of building them up again—are at their lowest level, and if we do so under different conditions, say at two different temperatures, then the difference in the amount of oxygen used will measure the effect of the change of temperature. Again, if we measure it with two different oxygen supplies, then the difference in the amount used (if there is any) will measure the effect of the rise or fall of available oxygen. We can, in this way, estimate the influence of summer and winter temperatures, and the influence of a plentiful or a restricted supply of oxygen.

The Supply of Oxygen

With regard to the supply of oxygen, in atmospheric air the percentage is very constant. At sea-level, that is to say, in the habitat of most insects, we find 20·9 per cent. of oxygen, roughly a fifth of the air ; there is just a trace of carbon dioxide, and the remainder may be taken as nitrogen. Under earth, where we find beetles and other insects, the amount of oxygen will vary according to the vegetation and the nature of the soil. At four inches down almost normal percentages of oxygen have been found, but in stagnant soil, or badly drained soil after rain, the percentage of oxygen may be greatly reduced ; values as low as 6 per cent. have been found.

In water the amounts of oxygen, carbon dioxide, and nitrogen present will be proportional to their pressures in the atmosphere, and in nature they will depend in the highest degree on the mixing to which the water is subjected. It will absorb air at the surface, but the air will spread downwards only very slowly by diffusion. Now in summer the surface water is warmest and therefore lightest, and, apart from wind, no mixing will take place. In autumn the surface water is coldest, the water will be well mixed and will be practically saturated with air. At temperatures below 4°, the point of greatest density of water, there will again be no spontaneous mixing, so that a winter minimum would also be expected,

and its non-occurrence is due to mixing by wind. In water with much vegetation the conditions are again changed. The plants give off oxygen, and in absence of mixing, the tension may rise as high as 40 per cent. in the lower depths, a fact that may be of great importance to animal life.

Pupal Respiration

With this short review of the general conditions, let us take the simplest case, the respiration of a pupa in air. Taking demand first, Professor Krogh has shown that chrysalides of *Tenebrio molitor* (the larva of which is the "meal worm") show first, reckoning from the commencement of pupation, a rapidly decreasing oxygen consumption, corresponding to the breaking up of the larval tissues. The decrease takes not much longer time at low than at high temperatures. Then there is a resting period with a nearly constant metabolism, and the length of this pause depends on the temperature. It lasts about 50 hours at 33°; 70 hours at 27°; 100 hours at 24°; and 170 hours at 21°. Thereafter there is a rapid increase in the rate of oxygen use, until metamorphosis takes place. It is interesting to note that the total amount of oxygen used in the process of pupation is the same at all temperatures; that the process is not more economically executed at one temperature than at another, and there is, therefore, no "best" temperature, except from the point of view of speed.

Now the oxygen is available for the use of the pupa only by diffusion over its surface. Without going very deeply into the laws of diffusion, let us recall the essential points. Gases diffuse much more rapidly in air than in water, and still more rapidly through air than through animal tissues. Carbon dioxide diffuses twenty times more quickly than oxygen, and oxygen three times as quickly as nitrogen. The biological significance of the rapidity with which carbon dioxide diffuses is great. The speed with which it diffuses from animal tissues, where it is constantly being produced, into air or into water, provides that there will never be any accumulation in the tissues, that the chief waste-product of respiration is quickly and easily eliminated. Whether diffusion will take place from any one medium to any other depends on the tensions of the gases present. Thus in atmospheric air over water, if no oxygen is passing either way, we say that there is a tension of 20 per cent. of an atmosphere in the water, and air and water are in equilibrium as regards oxygen. But if there is less oxygen in the water, so little, for instance, that it would be in equilibrium with air containing only 15 per cent. of oxygen, then we say that there is a tension of 15 per cent. in the water, and, in contact with atmospheric air, there will be a pressure-head of 5 per cent. to drive oxygen into the water. The higher this pressure-head, the more quickly will oxygen diffuse into the water. Accordingly the rate of diffusion of air into the body of the pupa will be proportional to the difference in pressure between the external supply and the tension in the body tissues. There will be a point at which the amount of oxygen entering will just counterbalance the consumption, and so, at constant temperature, with constant metabolism, we should expect the tension in the tissues to be at a constant level below the tension in the surrounding air. A rise of temperature—which we saw means an increase in demand for oxygen—with the same oxygen pressure outside, would mean that the tension in the tissues would have to be lower in order that the needs of the animal should be supplied. And, in fact, Dr. Gaarder found that to provide for the needs of the Tenebrio pupa during the resting period, at 20°, a pressure-head of about 5 per cent. of oxygen is required. It follows that a reduction in the percentage of oxygen in the air (while the temperature remains the same) will have no effect on the metabolism so long as this pressure-head of 5 per cent. is maintained. As soon as it fails (and then there will be a zero oxygen tension in the tissues), the oxygen diffusing in will be insufficient for the needs of the pupa. At a higher temperature—Dr. Gaarder took 32°—the oxygen consumption of the pupa in the resting period is a little more than twice as great as at 20°, and the tension in the tissues is 10·7 per cent., giving a pressure-head of about 10 per cent. Thus the pupa will suffer insufficiency of oxygen at tensions lower than 10 per cent. at this temperature. If the supply of oxygen is reduced below these critical tensions, what happens? The consumption of oxygen falls correspondingly to the fall in the external pressure, but, when the pupa is restored to a plentiful supply, the consumption rate rises at once, not only to the normal, but above the normal, and remains for a time at this high level, finally coming down to the normal rate. When income is not equal to requirements, since the demand is already at its lowest level and cannot be further reduced, reserve measures must be used. The tissue stores are burned in the fire of life without being built up again. The works must be kept going; capital is used, and when a plentiful income is again possible, the capital must be restored. The income must be abnormally high for a time to balance the period of depression.

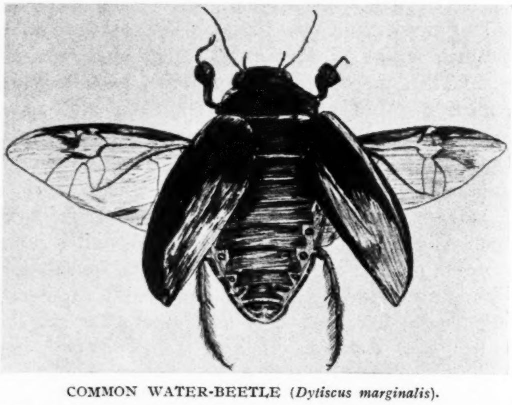
That is the simplest case, and it contains all that is essential to the understanding of the general problem. The main arguments apply equally to all forms, to larvæ and pupæ alike, in air or in water, and to the great class of adult insects. Diffusion may be over the whole surface, or through an elaborate system of

air-passages. Let us just note in passing one consequence of these facts, that the possible rate of diffusion through long and narrow air-passages sets a definite limit to the possible size of insects.

Water-beetles

And so we pass on to the complication which arises in the case of air-breathing insects in water—Dytiscus, the "diving beetle," and Notonecta, the "water-boatman," for instance. It is well known that these forms carry bubbles of air down with them from the surface when they dive (some others collect bubbles in the water), and it has long been disputed whether the bubbles are used in respiration, or are merely a sort of "water-wings." Let us take Ege's account of Notonecta. Notonecta has, on the thorax, three pairs of breathing-holes sunk in cavities which are in communication with the depressions in which the abdominal breathing-holes lie, all being roofed in by delicate hairs which form a covered way. There, a layer of air always clings, and this layer is, in turn, in communication with a layer of air on the wings. This air-supply has, as in Dytiscus and other forms, an important hydrostatic function. Without it, these insects, instead of being passively borne to the surface to breathe, become heavier than water and fall to the bottom. Normally, when it is active, Notonecta comes to the surface to breathe at intervals of about 6 minutes. Prevented from so doing, it can live for 6·7 hours in water saturated with atmospheric air. This might be due to any of four possibilities: (1) that the air carried down in the air-passages is sufficient for that time and that the function of the air-bubbles is hydrostatic only; (2) that the air in air-passages ***and*** air-bubbles is sufficient for that time; (3) that the air carried down is not sufficient, but that the animal respires without air (using its capital); or (4) that the air taken down is insufficient, but that the animal acquires a further supply from the water by diffusion into the air-bubbles. First, then, a Notonecta deprived of its air-jacket lived only 15 minutes in water saturated with atmospheric air, so that the first supposition is impossible, and the bubbles must be of use in respiration, since it lives 6 hours with them. Next, a Notonecta allowed to fill its air-passages in atmospheric air and then enclosed in water saturated with nitrogen, lived only 5 minutes, so that the total original supply was exhausted in 5 minutes; and again, allowed to breathe *pure oxygen* and then enclosed in water *saturated with oxygen*, it lived only for 35 minutes. This is not so strange as it seems. The Notonecta carries down a bubble of pure oxygen, and its air-passages are full of oxygen. As it uses up this supply, carbon dioxide will be given off from the tissues into the air-bubble, and, from it, will pass immediately into the water on account of its great solubility in water. There will be no accumulation of carbon dioxide in the air-store. The bubble will continue to consist of 100 per cent. oxygen (while the insect constantly draws from it), and no pressure difference can arise between it and the water. Hence no oxygen can pass from the water to the air-store, and the animal will simply use up its bubble. Under these circumstances it lived for 35 minutes, but there it had 5 times its normal supply of oxygen, 100 per cent. instead of 20 per cent., so that its normal supply would have lasted 7 minutes.

Now, Notonecta deprived of air does not live on its capital stores, for then it would have lived longer in



COMMON WATER-BEETLE (*Dytiscus marginalis*).

nitrogen. What does happen is this: as the insect uses the oxygen available in its air-passages and bubble, the tension of oxygen in the bubble will fall so low that oxygen will pass from the water into the bubble. Ege found that after being 2–4 minutes in the water, the bubbles contain as little as from 5 per cent. to 2 per cent. of oxygen, so that there is a big pressure-head available to drive more oxygen into the bubble. The rate at which oxygen will be supplied in this way will depend on the size of the bubble as well as the pressure-head, and Ege has calculated that for a Notonecta with a full air-supply, which will have a surface of about 75 square millimetres, a pressure-head of 5 per cent. oxygen would be sufficient for the *resting* needs of the animal at summer temperature. At a low temperature, with reduced standard metabolism and little activity, the air supplied by diffusion ought therefore to be amply sufficient to maintain life, even when, as in frozen pools, access to the surface is altogether prevented.

Where the Mechanism Fails

In view of these facts, how does it happen that any limit is set to the life of a Notonecta in water saturated with atmospheric air? This depends on the fact

already noted, that the carbon dioxide evolved in respiration is rapidly dissolved in the water; in consequence the air-bubbles may always be taken as composed of oxygen and nitrogen alone. Now we saw that a tension difference of 5 per cent. is required for the resting needs of the animal, and the composition of the air in the store would then be 15 per cent. oxygen and 85 per cent. nitrogen. These tensions will be maintained by the uniform consumption of oxygen and elimination of carbon dioxide. But the nitrogen tension in the water is only 80 per cent., so that nitrogen will diffuse out from the air-store into the water and *the bubble will disappear.* In the meantime the oxygen diffuses in three times as quickly as the nitrogen diffuses out, so that, by this means, the insect procures thirteen times as much oxygen as it originally carried.

LIST OF PAPERS

August Krogh, "Ein Mikrorespirationsapparat und einige damit ausgeführte Versuche über die Temperatur-Stoffwechsel-Kurve von Insektenpuppen." (*Biochem. Zeitschrift*, 1914.)

August Krogh, "On the Rate of Development and CO_2 Production of Chrysalides of *Tenebrio molitor* at Different Temperatures." (*Zeitschrift f. allg. Physiologie*, 1914.)

August Krogh, "The Quantitative Relation between Temperature and Standard Metabolism in Animals." (*Internat. Zeitschrift f. physik-chem. Biologie*, 1914.)

Torbjørn Gaarder, "Über den Einfluss des Sauerstoffdruckes auf den Stoffwechsel." (*Biochem. Zeitschrift*, 1, 1918.)

Richard Ege, "On the Respiratory Function of the Air-stores carried by some Aquatic Insects (Corixidæ, Dytiscidæ, and Notonecta). (*Zeitschrift f. allg. Physiologie*, 1915.)

Reviews of Books

WATER AND LIFE, AND OTHER MATTERS

The Animal and its Environment. By L. A. BORRADAILE, Sc.D. (Henry Frowde and Hodder & Stoughton, 18*s*.)

Dr. Borradaile has chosen so vast a subject that, as he states in his preface, he "could do little more than sketch the framework." This, however, he has clothed with many illuminating details. He has shown great skill and sound judgment in his choice of the various aspects of the subject on which he writes. Out of fourteen chapters, six deal with the fauna of the land, the seas, and the fresh water, and these are particularly well worth attention. He has an illuminating paragraph on the part that water plays in the life and structure of animals. William Watson has written a verse:

> "Magnificent out of the dust we came,
> And abject from the spheres."

But I do not think the poet knew much about our origin. As Dr. Borradaile says, "Water is the natural home of all living beings, and there is no doubt that life started in it." Within the body it is of the utmost importance, both as a constituent of protoplasm and as a circulating medium. It is a great solvent. There is no other liquid which dissolves such a number and variety of substances, and, what is equally remarkable, is that on the great majority of them it exercises no chemical action. With the exception of mercury, it has a higher surface tension than any other liquid, and this to some extent explains the mystery of the ascent of sap in trees. It also has the highest specific heat of all liquid or solid substances under ordinary conditions; or, in other words, it requires more heat to warm it to a given number of degrees than an equal mass of any other matter. It is, further, transparent, a matter of great importance to such animals as have eyes, and to animals which are partly nourished by the presence in their body of certain algæ. The remarkable fact that the salinity of our body closely approximates to the salinity of normal sea-water is shown by the fact that living tissues, when removed from the body, are best kept alive when they are in a normal salt solution; and in cases of cholera, where water is being poured forth from the body at an abnormal and amazing rate, the injection of normal salt solution brings relief and often effects a cure. The fact that even in the mammalia the embryo possesses gill-slits and a fish-like circulation and is surrounded by watery fluid is emphasised by Gibbon at the beginning of one of the six sketches of his autobiography. He tells us that "after nine months of an aqueous existence I was painfully transported to the outer world."

Dr. Borradaile writes in a plain, straightforward style, rather compressed owing to the magnitude of his task. As an example of his clearness we may quote a paragraph from his chapter on Parasitism:

> "The relations between *parasite and host* vary enormously, both in kind and in closeness, in different cases. A parasitic organism is one which, living on or in some other organism, and deriving food or some other benefit from it, in some way harms it. The benefit accruing to a parasite is nearly always nutriment, but it may also, or only, consist in transport or shelter. The harm which it does may consist in damage to tissues, abstraction of nutriment, or the excretion of poisonous substances. The series of such cases ranges from some which hardly differ from the preying of a small animal upon a large one—there is no great unlikeness, for instance, between the habits of a mosquito and those of a flea—to internal parasitism of the most intimate kind; and from others that are not unlike the harmless associations of organisms which we shall presently describe as 'synœcy,' to the causing of fatal diseases."

The book has almost an embarrassment of illustrations; so many, indeed, that it is impossible to place them near the subject-matter. There are four good coloured plates and 426 figures, whose reproduction varies in merit. Some of them are distinctly poor. The book is crowned by a most adequate index extending over seventeen pages. Its price of 18*s*. is distinctly moderate.

A. E. SHIPLEY.

THE EVOLUTION OF MAN

The Evolution of Man. A Series of Lectures delivered before the Yale Chapter of the Syma during the Academic Year 1921–2. By RICHARD SWAN LULL, HENRY BURR FERRIS, and others. Edited by GEORGE ALFRED BALLSELL. (New Haven: Yale University Press; London: Humphrey Milford, Oxford University Press, 15*s.*)

The occasion of the delivery of the lectures contained in this book is sufficiently indicated by the sub-title. Intended as a sequel to a series of lectures on the evolution of the earth and its inhabitants delivered to the same club some few years earlier, they take up the specific study of man from the evolutionary standpoint on several sides. The lectures are six in number. Of these, two are purely physical, one psycho-physical, one psychological, one is cultural, and one, the last, is an attempt to forecast the lines of Man's progress in the future—an attempt which, it may be said, is not so fantastic as might be thought at first sight, but is based on sound methods of scientific analysis.

These essays have a double interest. In the first place, being delivered to a non-specialist but educated audience, as a whole they present a survey of the present state of knowledge in certain departments of anthropology in a form which will commend itself to those who wish to acquaint themselves with the latest results of research, but do not wish to be overburdened with technicalities. In the second place, they represent the current views of American scientists on many problems which are the peculiar province of European anthropologists, and for which the evidence is derived mainly from the Old World and, particularly, from Europe. As a result, matter is presented to English readers from what, in many cases, will be a new point of view.

Of the six essays, the first, by Professcr R. S. Lull, deals with the antiquity of man. He surveys the evidence, geological and archæological, for the antiquity of man, adopting the view of Osborne that Mr. Reid Moir's Foxhall flints from East Anglia are to be accepted as evidence for man in late Tertiary times. But it may be noted that he still holds the view at one time general in America, that while the cranium of the Piltdown Skull, the oldest skeletal remains of man found in Britain, is human, the jaw associated with it is simian. Professor Osborne himself has, however, now abandoned this view and accepted it as human. Professor H. Burr Ferris's lecture, on the natural history of man, traces the growth of man from the cell through prenatal and postnatal development to senescence, dealing with each of the organs in detail. This is a very useful exposition of a subject not as a rule adequately treated for the benefit of non-technical readers, and the same applies to Professor G. H. Parker's lecture on the evolution of the nervous system of man. Professor J. R. Angell's essay on the evolution of intelligence contains the essentials for an understanding of the place of human intelligence in the evolutionary scale. If, from the anthropologist's point of view, it may seem too general in character when dealing with questions of racial psychology, this must be attributed not so much to the author as to the fact that it attempts to give an outline of a subject for which accurate scientific data are almost entirely lacking.

Professor Albert G. Keller, in "societal evolution," has chosen to deal with the general principles of study rather than attempt to handle the ascertained facts of the course of development in human society. In this he has shown wisdom, and his lecture will prove a useful corrective to the facile theories which unfortunately have frequently been allowed to usurp the place of clear thinking and accurate detailed verification by comparison with the facts. Of Professor E. G. Conklin's theories of the trend of evolution enough has already been said to indicate that his method is strictly scientific; of his results, each reader must judge for himself. It must be said, however, that in a sense they sum up the teaching of the book and lend support to those who hold that the study of man as he has been in the past and as he is to-day should throw light upon what he will become in the future.

E. N. FALLAIZE.

FREUD ON LIFE AND DEATH

Beyond the Pleasure Principle. By SIGMUND FREUD. Translated by C. M. HUBBACK. (Allen & Unwin, 6*s.*)

Throughout the development of his theories Freud has always held that the one ultimate motive of all human conduct was the desire to avoid pain or to gain pleasure, though the immediate gratification of the desire might be postponed in the hope of a deeper and more lasting fulfilment. But the suspicion crept in that behind the "pleasure-pain principle" there might be another, altogether different motive, and with the access of new psychological material from the study of the war neuroses the suspicion was confirmed, for in the cases of war shock one of the most frequent symptoms was the recurrence of terrifying dreams in which the patient lived through again and again the experience that caused his illness. Here was a phenomenon that could not be explained by the old formula that the dream is invariably the expression of an unconscious wish.

Freud accordingly gives up the universal applicability of the formula and of the pleasure-pain principle to seek for a new motive in what he has named the tendency to repetition or the "repetition compulsion," a tendency or instinct in every living organism "impelling it towards the reinstatement of an earlier condition."

The phenomenon of repetition is familiar enough in biology, so familiar that, perhaps, we have missed its importance; we have only to recall the compulsive migration of birds and fish back to the original home of their kind, and, perhaps the most perfect example of all, the way in which every individual in its development from the germ-cell is obliged to recapitulate the structural history of the race "instead of hastening along the shortest path to its own final shape."

This conception of a fundamental regressive tendency in the organism is diametrically opposed to our ordinary view of the instincts as urging on towards progress and

development, for it is an urge not towards life but towards death. Freud conjectures that the first living material that appeared upon the globe retained its vital properties for but a short time, quickly relapsing into the chemical stability of inanimate matter, to be vitalised anew by the action of whatever external force it may have been that was effecting so momentous a change in a hitherto lifeless world. But as the living structure became more complex and more different from the non-living, the path back to the inanimate became longer and more circuitous, so that the living organism of to-day is compelled to go through a varied life-cycle before it can return to the inanimate from which it started. Since it is rigidly dominated by the repetition compulsion, it is unable to short-cut the path and is compelled to reach its goal of death by retracing the complicated course of its evolution.

This tendency to go back to the beginning, bound up, according to Freud, in the very stuff of life, is antagonised by the sexual instincts, and it would seem legitimate to consider it (though Freud does not apparently go so far as this) to have been overcome by them, for reproduction ensures a potential immortality for part at least of the organism (the germ-plasm) and has brought about the continuity of living matter.

Here we may note a further modification of Freud's theories; he now groups together "sexual instincts" and the "ego-instincts" (i.e. fear, hunger, and the self-protective instincts generally) as "life instincts," retaining the dualism of his psychology by this conception of a deeper, more primitive, regressive impulse or "death instinct'" in opposition to them.

Evidence of the conservative and repetitive aspect of the regressive impulse is easy to find in human psychology, but the manifestation of its deeper aspect as a hidden but universal striving for death is, Freud admits, very obscure and difficult to detect, and he cites only one example of it.

Even if the supporting evidence were less slender, we should find a temperamental difficulty in accepting a pessimism so profound and unequivocal; Freud himself seems to have done his best to escape his own conclusions, and he will not admit that they are, as yet, much more than speculation, "often far-fetched, which each will, according to his particular attitude, acknowledge or neglect. Or one may call it the exploitation of an idea out of curiosity to see how far it will lead." Yet the conclusions themselves, if we consider them apart from the way by which they were reached, are not so very unfamiliar nor so very different from the pessimistic philosophy of Buddha with its goal in Nirvana that can only be reached when the compulsion to rebirth has been overcome, or the pessimism of all the poets who have sung of their weariness of life and the desirability of death to an unconvinced world. But whether we accept the theory or no, there is not likely to be much tendency to neglect, as their author pessimistically foreshadows, the work of a profound and original thinker, however uncomfortable may be the conclusions to which an unflinching intellectual courage may lead him.

Great pains have evidently been taken with the translation, and Miss Hubbaçk may be congratulated on the way in which she has accomplished a very difficult task.

F. A. Hampton.

A FORECAST OF FUTURE WARFARE

Reformation of War. By R. de la Bere. (Hutchinson, 16*s.*)

This is the title of an imaginative and brilliantly written treatise on future wars. The author is a heretic and "tears up forcibly the old testament of war." In his own words, he believes in original thoughts and "spews out like a nauseous draught the mental drug called imitation." He divides human beings into two classes, the masters (the supermen) and the slaves (the supermonkeys), the creators and the imitators.

In his opinion there are too many imitators in the three services. The world has changed, and so, he considers, has the true art of war. "The brass bottle of scientific warfare has been fished up"; its seal has been broken: and no contempt for science and no reaction to the tactics of the stone hammer, the arquebus, or the matchlock will coax back the Jinn.

Since '70 the art of war has advanced in seven-league boots, and yet, he says, here are soldiers still forming fours and making goose steps. He is out against traditionalism; he is out to slay the dragon of armies and fleets and air services spellbound by the past.

His argument proceeds to practice through biology and ethics. "The law of life is war"; "life lives upon life"; and war in one form or another is inevitable. He has no truck with the League of Nations. War, he thinks, will always be. It is a national tonic—a useful purge.

But to him the art of war is to keep the bulk of your men *alive*.

To keep your men alive, you must keep your movements, your weapons, and your morale alive. Furthermore, you must hit your enemy from a safe distance or you must hit him at safe close quarters. For he claims that there are two great fallacies in the modern theory of war: (1) that in war a nation's will is best enforced by *destruction*, and (2) that victory is based on numbers. These fallacies, he says, led to the slaughter-houses of the Somme and Ypres: whereas, he says, the supreme duty of the soldier is to fight and not to die.

Fighting in future is to be short and safe. He points out that at the preliminary bombardment of the Hooge, the Somme, Arras, Ypres, we fired nine million shells, that is, 100,000 tons of shell, estimated at twenty-two million pounds sterling. If it had resulted in victory, it would have been cheap at the price; but it did not result in victory. Roads, lanes, tracks vanished under the earthquake; impassable craters were formed. It was not modern war. It was, he says, like beginning a big-game shoot with a fortnight's solo on a bassoon.

The writer has no use, then, for shell bludgeoning, e.g. at Gallipoli; or for Brusilov's shock tactics which cost him 375,000 casualties in twenty-seven days; and he thinks that Germany wisely broke from tradition when

our blockade began to tighten. She boldly broke international rules again and started to hit below the belt—in the mind of our humanitarians. But to the writer of this book, war is a game in which there is no belt under which one may not hit. There is, indeed, to him, a great risk of submitting the tactical to the ethical in war.

This is the moral which the writer draws now that, as he claims, in the Services, Tradition is rising again from her ashes—in spite of the stride of new ideas everywhere else. He sketches new methods of war which will compel nations to throw up their hands and make peace within a few days, possibly a few hours, of war being declared.

He says that 1914 saw the last lap of the physical epoch of war ; and that " now begins the first lap of the moral epoch."

Firstly he urges the use of gas. It is to be a universal weapon employed by all arms. One of his strongest arguments for gas is the enthusiasm with which most people are agreed to execrate its horrors. The use of gas has been described as " one of the most bestial episodes of the war—the very negation of civilisation."

But Colonel Fuller regards it, properly used, as the weapon of the future, because it is easy and cheap to manufacture ; because it economises lives on the battlefield ; because the gas of which he is thinking incapacitates without killing ; and because it does not injure property. For he is not thinking mainly of toxic gases. He does not regard killing as the object of war. Conceivably it might be necessary sometimes to use toxic gases. Even so, is toxic gas so inhumane as " the weedlings " assert ?

The American General Staff have categorised their casualties. Twenty-seven per cent. were due to gas, and 2 per cent. of the gas casualties were fatal. He concludes with them that gas is twelve times as humane as bullets and high explosives. But he urges mainly the use of smoke and gas, which can put troops or civilians temporarily out of action.

He urges the closest sympathy between soldiers and scientists, and continuous research on gas warfare. Allowing for another big war in 1972, he considers that we should have soldiers who can pit brains against beef, and by science, on the roughly indicated analogy of gas, win a battle in " a day without a night."

Secondly, in the same spirit he advises the use of " General Tank." His tank will move forward in front of the infantry. It will offer a small target, and be gas-tight and bullet-proof. It will make twenty miles per hour. It will be invaluable in small wars, e.g. in a move from Pesshawur on Cabul. It will put gunnery out of date. Gunners against tanks will have to lay over the open sight and in respirators ; for the tanks may bring up gas.

There will be swimming tanks, too, and tanks that can be carried in submarines ; for wars in future on land and sea will be waged by machine power rather than by man power, though the writer wisely allows the value of the blare, the thunder, and the flash of cavalry in open warfare. He does not expect again the long war of attrition, in which cavalry has no chance.

Thirdly, he has downright views on aerial warfare. He regards sea-fighting as a prodigal method of war. He can picture a fleet of capital ships put out of action from the air by smoke, and toxic or non-toxic gas. In the future fleets will consist only of submarines or aeroplanes. The latter will move by hundreds, carrying thousands of bombs and bombing capital cities and other vital centres.

The airship will be useful for the carriage of supplies, as it is too slow and has too low a ceiling to come into action. It will be a mobile aerodrome for planes, which will attack at a great height and then swoop down and traverse with machine-gun fire bodies of enemy troops from van to rear, or open tanks of vesicant chemical, which will paralyse the traditional soldier.

Many critics will rush violently down to attack the gallant author, whose ideas are too fantastic and far-fetched for the man who after the Armistice exclaimed : " Now, thank God ! we shall be able to get back to real soldiering."

The idea of the book may be fantastic ; it may seem the creation of the pseudo-scientific novelist rather than of the practical soldier. But the author admits that he only adumbrates the lines on which future wars will be fought, and regards his work only as a stimulus to progressive thought. He does not tie himself to any cast-iron principle or practice.

His book will cheer up the civilian, particularly the politician, for whom it holds a promise of war that is cheap as well as humane.

The book is of great interest, but open to a great amount of criticism. Two criticisms especially strike the reviewer. Firstly, it begs the question that the rôle of war is to keep men alive. On this premise rest all the conclusions. But the philosopher, or any practical man, whatever his scientific bent, will find it hard to reconcile this premise with life, as we know it. The premise may be excellent humanity, but it is very poor science. You cannot draw an abrupt line between man and other animals, and deny, for instance, the common laws of life, and the instincts of pugnacity, fear, and acquisition, which make nations periodically spoil for a fight, in which blood must be let.

Secondly, if war could be fought and won in a couple of days, in a couple of weeks, or in a couple of months, could it be claimed that such a war had been fought " to a finish " ? Would not your foe feel that he was beaten because his opponent had taken advantage of him by a sudden scientific trick ? Life would be volcanic and precarious indeed with such methods of war, for one would be substituting endless rounds rapid for one continuous and conclusive bout.

MEASURING A NATION'S INTELLIGENCE

A Study of American Intelligence. By CARL C. BRIGHAM, Ph.D. A Foreword by ROBERT M. YERKES, Ph.D. (Humphrey Milford, Oxford University Press, 16*s.*)

In a play by Mr. Israel Zangwill which met with considerable success when it was produced, some years ago, America was pictured as a " melting-pot," wherein all

the nations of the world came together and were transformed into one harmonious whole. America had the property, it was suggested, of altering the new-comer, rounding off his corners, and producing an American—a distinct species, which nevertheless could be manufactured out of anything. It appears that Americans themselves seriously doubt this engaging theory, and the doubt gains expression in the book, which describes the results of a methodical study of the intelligence of recruits for the American army during the Great War. The tests employed were of two classes—one for more or less educated individuals who could speak the English language, and one for the illiterate, or those who know no English. The first series, in general, consisted of a number of questions, to which a selection of answers was provided, only one of which was correct. " How many legs has a Kaffir ? Two, four, six, or eight ? " is an example. The second series consisted of illustrations, containing some obvious error to which attention was to be directed, or of geometrical figures to be arranged in a given way. Throughout there was a very strict time limit.

Tests of this nature invariably amuse all save the psychologist, who is himself convinced of their value, and is gradually convincing others. They are widely used in this country, both as examination for Civil Service entrants and for industrial investigations, such as the selection of a vocation—draughtsman, fitter, turner, etc., for a young aspirant to a trade. The time limit, in a test of general intelligence, seems out of place, since it is obvious that many occupations tend to produce a type of mind more capable than the majority of a quick decision. Moreover—an objection which the author anticipates—some of the actual questions seem ill chosen. " Denim is an ' ad ' for a drink, revolver, flour, cleanser," is an example of a test which obviously would condemn a recent visitor to America who, wisely or otherwise, did not study the local press.

Still, just as any method of choosing a Parliament would be as satisfactory as any other in the long-run, so doubtless these tests answer their purpose well enough. They show, as the author says, that " according to all evidence available, American intelligence is declining and will proceed with an accelerating rate as the racial admixture becomes more and more extensive." This is attributed to the effects of immigration. There is a careful analysis of the intelligence of each immigrating nation. The order of merit is Holland, Germany, Denmark, England, Scotland; Ireland comes seventh and Poland last, nearly 7 per cent. of her candidates being below the mental age of eight. Of the negro recruits, 10 per cent. fell below that standard.

An interesting relation is shown between intelligence and length of stay in the country. The longer the stay, the more intellectual was the candidate. The explanations possible are—first, the melting-pot theory; secondly, that only wise men stay in America ; lastly, that a better type used to come to that country than now does. We note that the French nation is not represented in the figures given ; no explanation—not even that no Frenchmen are wise enough to stay in America—is offered.

In a leading article in *The Times* for May 26, the same problem as it affects Canada is discussed. It appears from the work of Dr. C. K. Clarke, of the University of Toronto, that a most undesirable collection of individuals is being sent to that country by immigration societies. The question is certainly a difficult one. The individuals are objectionable, socially speaking, wherever they are. The world as a whole is none the better off for any effort to exclude them from any one quarter. Moreover, it is undeniable that Australia was colonised, in part, by convicts, even though convicts in those days were drastically punished for small crimes. None the less, Australians as a whole are among the finest physical types of men living on earth. No solution of the general problem is offered in this book ; but as a record of careful work, yielding most interesting results, it will repay serious study.

R. J. V. PULVERTAFT.

Books Received

(Mention in this column does not preclude a review.)

ARCHÆOLOGY AND ANTHROPOLOGY

The Oldest Letters in the World Tell Us—What? By MRS. SYDNEY BRISTOWE. (George Allen & Unwin, Ltd., 5*s.*)

From Stone to Steel. A Handbook to the Cases illustrating the Ages of Stone, Bronze, and Iron in the Horniman Museum and Library. Second Edition, 1923. (Published by the London County Council and obtainable from P. S. King & Son, Ltd., or any bookseller, 6*d.*)

Tutankhamon and the Discovery of his Tomb. By PROF. G. ELLIOT SMITH, F.R.S., etc. (George Routledge & Sons, Ltd., 4*s.* 6*d.*)

MISCELLANEOUS

Flying Round the World. By MAJOR W. T. BLAKE. (Heath Cranton, Ltd., 12*s.* 6*d.*)

The Wheelwright's Shop. By GEORGE STURT. (Cambridge University Press, 12*s.* 6*d.*)

The Elephant Man and Other Reminiscences. By SIR FREDERICK TREVES, G.C.V.O., etc. (Cassell & Co., Ltd., 7*s.* 6*d.*)

Origins in Place-names. By an Ignorant Student. (London : Privately printed at the Chiswick Press.)

PSYCHOLOGY

Heredity and Child Culture. BY PROF. H. D. CHAPIN, M.D. (George Routledge & Sons, Ltd., 6*s.*)

Character and the Unconscious. By J. H. VAN DER HOOP. Translated by ELIZABETH TREVELYAN. (Kegan Paul, Trench, Trübner & Co., 10*s.* 6*d.*)

Self-healing by Auto-suggestion. Translated from the French of H. DOLONNE. (J. M. Dent & Sons, 3*s.* 6*d.*)

SCIENCE

The Wonders of the Stars. By JOSEPH MCCABE. (Watts, 3*s.*)

I Principî della Meccanica alla luce della Critica. By GIUSEPPE CASAZZA. (Societa Editrice Dante Alighieri di Albreghi, Segats & C., L. 8.50.)

The Physiography of the McMurdo Sound and Granite Harbour Region. By GRIFFITH TAYLOR, D.Sc., F.R.G.S., etc., C. S. WRIGHT, O.B.E., M.C., and R. E. PRIESTLEY, M.C. British (*Terra Nova*) Antarctic Expedition of 1910–13. (Harrison & Sons, Ltd.)

The Natural History of Wichen Fen. Part I. Edited by PROF. J. STANLEY GARDINER, F.R.S., and A. G. TANSLEY, F.R.S. (Bowes & Bowes, 3*s.* 6*d.*)

Scientific Method. By A. D. RITCHIE. (Kegan Paul, 6*s.*)

The Phase Rule. By A. C. D. RIVETT. (Oxford University Press, 10*s.* 6*d.*)

Dreams of an Astronomer. By CAMILLE FLAMMARION, Translated from the French by E. E. FOURNIER D'ALBE. (T. Fisher Unwin, 10*s.* 6*d.*)

Petrology for Students : An Introduction to the Study of Rocks under the Microscope. By ALFRED HARKER, M.A., LL.D., F.R.S., F.G.S. Sixth edition, revised. (Cambridge University Press, 8*s.* 6*d.*)

The Properties of Engineering Materials. By W. C. POPPLEWELL and H. CARRINGTON. (Methuen, 28*s.*)

Six Great Scientists. By MARGARET AVERY. (Methuen, 2*s.* 6*d.*)

Correspondence

AXIAL ROTATION

To the Editor of DISCOVERY

DEAR SIR,

I was much interested in Mr. J. Marshall's letter upon Axial Rotation in the May DISCOVERY ; it is a difficulty which I have often met with in others during my many years' experience of teaching astronomical science.

In the first place Mr. Marshall has not got hold of the idea of the laws that govern lunar rotation, because he states that it seems to him that the moon must turn the same face to the earth if its period be what it is, or 28,000,000 years.

The moon-earth system is one that is bound together by tidal attraction, and this same force is tending to drive the moon farther and farther from the earth, which state of affairs is gradually slowing down the earth, but at the same time is speeding up the moon. The day will therefore come in the dim future when those who are then living will see the other side of the moon.

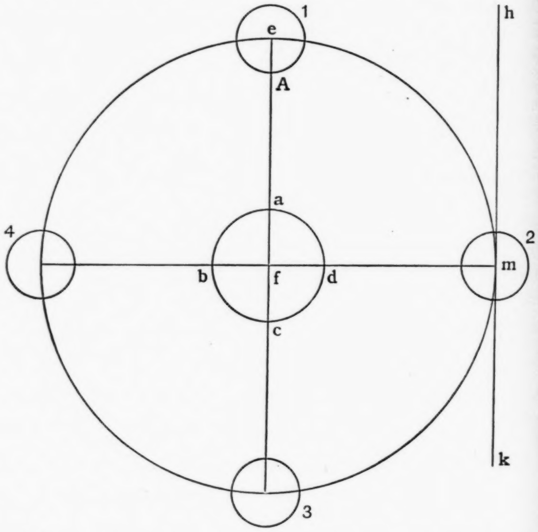
Mercury is almost certainly bound to the sun by the same tidal forces, but it is far more likely that Venus has a rotation period not very different from our own.

I think that by the aid of the diagram I have prepared Mr. Marshall's difficulty will vanish and he will see that in the various cases he mentions axial rotation is taking place.

We will first of all suppose the figure to be a section of the earth-moon system. Let the circle *abcd* be the earth, and let 1, 2, 3, 4 be four positions of the moon. Also let *e* be the centre of the moon, and *f* be the centre of the earth, and let A be a point on the moon's surface where the line *ef* cuts the moon 1.

Now if the moon simply revolved upon its orbit without rotation upon an axis, we see that the line *ef* will have shifted to *hk*, which must be parallel to *ef* when the moon arrives at 2. Therefore the point A will no longer be opposite the earth, but will be 90 degrees from the earth.

Now we know from observation that this is not the case, the point A must be opposite the earth whenever the moon may be upon its orbit, and therefore A is not on the line *hk*, but is on the line *mf* ; and thus the moon must have rotated through 90 degrees on its own axis, and so on for any other position.



We can thus show that a rotation of 180 degrees has taken place when the moon gets to 3, and 270 degrees when the moon arrives at 4 ; and therefore one complete rotation when the moon arrives back at 1.

The reason why a lunar observer at A will not see the earth rise and set is not because the moon has no rotation, but because the revolution and rotation are equal, owing, as we said above, to tidal attraction.

Now let the diagram illustrate the seconds dial of a clock, and it can be shown that if the disk did not rotate as well as revolve, it would break away from the hand.

In the diagram the hand is at 30 seconds when the disk is at position 1 ; and therefore the pivot of the hand is at *f* on the line 3*cfa*A*e*.

By the time the hand gets to 45 seconds the point A is on the line *bfdm* and not on the line *hmk* ; therefore A has rotated through 90 degrees ; and so on for any other position.

Mr. Marshall can employ the same diagram to work out his problem of a cricket ball on a string, and also the ball placed at the end of a railway turntable.

I am, sir, yours, etc.,

JOHN L. A. SILLEM.

12, ROTHSAY GARDENS,
BEDFORD.

April 30, 1923.

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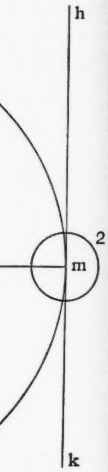

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